





RIVER GARDENS;

BRING

In Account of the Best Methods

OF

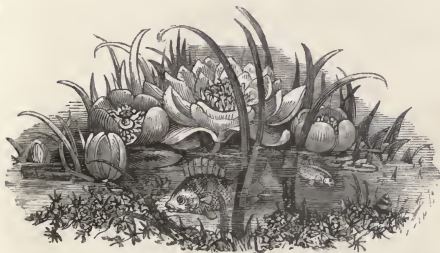
CULTIVATING FRESH-WATER PLANTS IN AQUARIA,

IN SUCH A MANNER AS TO AFFORD SUITABLE ABODES TO ORNAMENTAL
FISH, AND MANY INTERESTING KINDS OF AQUATIC ANIMALS.

BY

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AND THEIR TRANSFORMATIONS;" ETC.



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RIVER GARDENS.



CHAPTER I.

INTRODUCTION.

BY the culture of some of our most beautiful fresh-water plants, in glass Aquaria, many of the wild beauties of Nature, in some of her most pleasing and interesting aspects, may be wrought into attractive decorations for our ordinary living rooms, with very little trouble or expense.

But this is not the chief object of such Aquaria. Their formation has been suggested by the discovery that the growth of aquatic plants will maintain the water, contained in such a vessel, in a state of purity sufficient for the healthful existence of all kinds of animal life of which water is the natural element. By means of an Aquarium, therefore, the forms and habits of fish, reptiles, and aquatic insects may be made to develop themselves

under our eyes, undisturbed by the continual necessity of changing the water; thus affording us the curious spectacle of many phases of animal life that have hitherto lain concealed in depths inaccessible to the observation of the most curious observer.

I can well recollect my first longings, as a young naturalist, to unravel the mystery of the teeming world of life beneath the waters. The Pictures of those days are still vivid as things of yesterday. Perhaps more so; for later sensations are faint in comparison to those keen first impressions of nature in the days of early youth. I remember the eager, straining curiosity with which I endeavoured to look down into the transparent depths of the brooks and ponds of my native Warwickshire, seeking to trace the outline and movements of dim forms that I could imperfectly perceive gliding among the tangle of rushes and *Algæ* far beneath the surface. But one favourite fish-pond, in the orchard of an old house, the residence of a distant relative, riveted more than any other my greedy curiosity. I have lain for hours on the grassy border of that weed-grown water, peering between the floating leaves of the Frogbit, or Water Plantain, into the clear brown depths beneath. It seemed a world full of wonders. I saw

the great Water-beetle row himself swiftly past with his fin-like legs far below the surface—now darting through a clear open space, and now disappearing in the deeper shadows, or gliding away among the undulating stems of the water weeds. I saw the strange form of the same creature in its larva state, but did not know it then ; indeed what could lead me to guess that it was the infant shape of the same insect ?

As I lay there in the early summer sun, gathering the pink-tinged ears of the Soft-grass—of which I afterwards learned that the botanical name was *Holcus lanata*—the woolly *Holcus*, from the white and downy surface of its blade-like foliage—I turned again and again from my grassy bouquet to my world of mystery, deep in the water ; continually catching glimpses of some moving thing that increased my curiosity to the highest pitch. There was a certain exciting charm to a young lad, already an expert angler, in detecting the form of a great Jack lying suspended in midwater, enjoying his warm noon *siesta* ; or in seeing a noble Perch glide majestically past, urged forward by a dignified wave of his graceful tail—and with his great dorsal fin nobly erect, bristling with a defiant fringe of spears, which even the voracious Pike generally

considers an effectual defence. There is, as I have said, a certain indefinable charm, especially to a young angler, in watching these larger and better known denizens of the water; but how much more eager is the stirred curiosity to define the stranger forms of creatures unknown, or much less frequently observed, such as the larvæ of many semi-aquatic insects, or the early stages of the Newt, during which his external breathing apparatus, those mysterious branchiæ, appear like some parasitic plant springing from his head. How much more eagerly the eye follows the gem-like gleam, as it passes, which is emitted from the air-filled globule of the Water-spider, shooting past like an aquatic firefly, but bearing a flame of silver instead of gold; and then the mysteriously moving mass that contains the Caddis-worm, or the strange antics of the larva of the Gnat. These are the moving things, with hundreds of other kindred shapes, which fill the young imagination with elfin pictures, dream-like as those it might embody in some dark chamber of romance. How often did I try, frequently at the risk of falling headlong into the deep pond, to fish up some of the dimly-seen creatures which so strongly excited my curiosity! But they generally escaped through the meshes of the little net I had

contrived ; and one which I afterwards constructed of muslin was far too conspicuous in the water to afford me many chances of capturing the objects of my pursuit. Even when I was successful, and had the good fortune to see one or more of these curious inhabitants of the world of waters safely deposited in some earthen pan or bottle, I was seldom able to keep them many days. The young larva, disturbed by the continual changing of the water, to keep it fresh, died ; or, when I attempted to clean it undisturbed, the water itself became putrid, and had to be cast away, along with the miniature monsters I had hoped to make my pets, and preserve for a long time, observing and studying their evidently curious habits and instincts. I had one triumph, however. A strange scorpion-like creature, after exercising its voracious appetite upon every other living thing in the vessel in which I had placed it, seemed suddenly to lose all taste for the luxuries of the palate, notwithstanding a copious supply of the living delicacies it was most fond of, and with which I had taken care to furnish it at regular intervals. It became restless, and apparently diseased, and I concluded that I was about to lose this favourite specimen as I had lost so many others. Its uneasiness, however, took quite a different turn

to the one I expected, ending in nothing less than a determination to leave its native element. Had I seen a Carp or a Tench quietly walk out of the fish-pond and climb a tree, I could not have been more astonished than when I saw this creature of the water—which, with its fin-like tail and other appendages, was evidently intended for a denizen of that element, quietly crawl up a stick which was standing in the vessel, and emerging from the water, remain quietly attached to the support it had selected, at some inches above the surface of the element it thus so strangely and suddenly quitted. Its determination appeared the more astonishing, as I soon perceived that its finny tail, its legs, and at last the whole of its skin gradually hardened and blackened, and it appeared to have shared the natural fate of “a fish out of water.” After watching it for some days, without perceiving any further change, other matters occupied my attention and I entirely forgot the fate of my voracious pet, which had met such an untimely end in consequence of rashly leaving the proper sphere of its existence.

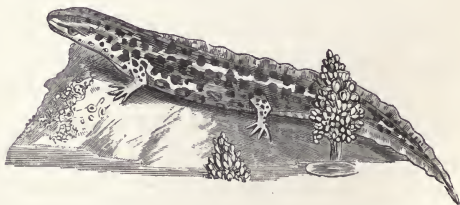
Some little time afterwards, I was about to empty the jar, and throw away the stick to which the dried and hardened form of the victim to getting out of bounds was still attached, when I thought I

perceived a division in the blackened skin of the back. As I saw that the opening widened, my curiosity became again excited, and I determined to watch and see if any other change would follow. Taking a book, therefore, I sat down near the object of my attention. I had not read many pages, turning frequently towards the remains upon the stick, when suddenly—I shall never forget the surprise of that moment—when suddenly, the opening of the back was much widened, as by some sudden effort, and the greater part of a glittering Dragon-fly became plainly visible; very quickly the whole insect emerged from the blackened shell, spreading its great gossamer wings to the sun, which was shining brightly through the window.

I had, by a lucky accident—for I can hardly call it the result of a course of observation—witnessed one of the most extraordinary and complete of the metamorphoses that occur in the whole range of insect life, and was all anxiety to pursue my discoveries. I was, however, baffled in all future attempts, at that time, to extend my knowledge of the mysterious creatures of the world of waters, and it was not till recent discoverers have shown how the Aquarium may be made the means of facilitating studies of that class, combined with an elegant and

delightful mode of amusement, that I resumed the course of observation which had been so long interrupted by difficulties that appeared insurmountable.

Now, however, that so much has been done towards smoothing the way, I have been again attracted to the long neglected aquatic studies, and snatch every moment I can spare from the literary labours which have carried my pursuits in a very different direction, to renew my old and ever pleasantly remembered acquaintance with the interesting inhabitants of our ponds and streams.



CHAPTER II.

DISCOVERY OF THE PRINCIPLES OF THE AQUARIUM, AND THE BEST MODE OF CONSTRUCTING ONE.



As I stated in my little essay on the formation of a marine Vivarium (entitled "Ocean Gardens"), the first clearly defined views upon the subject of the mutual interchanges of gases going on between vegetable and animal life, by means of which the vital principle in each was sustained, were put forth by Lavoisier, Priestley, and Ingenhauss, towards the close of the last century. The theories of Ingenhauss, especially those concerning the functions of aquatic plants, were announced in greater detail than those of Lavoisier and Priestley, the following passage being found in his last essay:—"Plants immersed in water, when exposed to the action of light, emit an air known as oxygen." The knowledge of this principle is the keystone in the construction of the Aquarium.

The first successful Aquaria were, nevertheless,

the result of accident rather than scientific experiment, as neither the establishment of *Aquaria* nor the illustration of the principles announced by Priestley and Ingenhauss were sought, when it was first found that fish would live longer and more healthily in vessels in which aquatic plants were growing, and also that the water, under such conditions, remained clear without artificial aeration, or the addition of fresh water.

Nevertheless, it is interesting to know who were the ingenious and philosophical experimentalists who first, while in pursuit of other results, became the means of demonstrating that a miniature "lake" or "ocean" could be constructed in a glass tank little more than a foot square, exhibiting the plants and animals peculiar to each, all maintaining themselves in a healthy condition, as in real lakes or oceans, without any further care being bestowed upon the little world after its first creation.

Mr. Ward, in 1837, threw out, incidentally, the first practical hints towards the formation of glass vessels, whether for terrestrial or aquatic plants, in describing the success of his attempts to grow ferns in closed glass cases. Dr. Johnston, in 1842, proved that sea water containing marine *Algæ* in a growing state, would remain pure for almost any

length of time, though the experiment he was prosecuting was for another and perfectly distinct purpose—that of ascertaining the true vegetable nature of corallines. Dr. Lankester, in his capital treatise on the Aquarium, states that he kept Sticklebacks in a glass vessel with a plant of *Valisneria*, in 1849, which was, in fact, a true Aquavivarium upon principles now adopted; but he did not then announce it as a discovery, nor probably consider it as such. Mr. R. Warrington was, in fact, the first (in 1850) to *publish*, in a paper communicated to the Chemical Society, a series of observations upon the subject. In that essay he entered, with some detail, into the functions assigned to plants for the conversion of carbonic acid gas into oxygen, and the consequent necessity of their presence for the preservation of animal life, which would otherwise, by the quantity of carbonic acid which it throws off, become poisoned by its own secretions. He further stated clearly that a third, or cleansing agency, was absolutely necessary, inasmuch as certain portions of plants, or the whole, having arrived at extreme maturity, naturally perished, and that the decaying matter so produced was calculated to cause as much injury as the superabundance of carbonic acid, or the absence of oxygen. In fact, parts of

the aquatic plants of his tank having so perished, he found the water become suddenly impure, and his fish die. In this state of affairs he had direct recourse to the book of Nature for further information. He examined natural ponds, in which a certain amount of decaying vegetation must necessarily be found, yet without causing putrefaction of the water.

His next step was, doubtless, to procure portions of such decaying matter, and examine its peculiar condition. It was then, we may imagine, that he found the remains in question covered with Water-snails, which, acting as natural scavengers, were consuming the putrescent substances as fast as they occurred, and so preventing the results which had proved so fatal to his tank. This was his great and original discovery. He added Water-snails to his tank, and the crowning element of success was achieved. Thenceforth his miniature lake went on as self-supporting as its great prototypes among the mountains, all the main conditions insisted on by the laws of Nature having been complied with. The reading of the paper containing these interesting facts, and the publication of subsequent essays on the same subject, in the "Annals of Natural History," must give Mr. Warrington the honour of being the more immediate founder of the Aquarium,

in its practical form, and upon true and distinctly announced principles.

Mr. Ward had, it is true, described in 1849 his success in growing marine plants in artificial seawater, which established another interesting feature connected with the establishment of *Aquaria*, though it had been previously proved by Dr. Johnston's experiment. He did not, however, make any statement in reference to the necessity for plants to sustain animal life in *Aquaria*, leaving it to Mr. Warrington, who had been so completely successful in his fresh-water experiment, to turn his attention to the establishment of a marine tank upon similar principles, in which he has been also more thoroughly successful than any other operator. Many have since followed in the track of the pioneers I have named, among the most distinguished of whom the names of Mr. Gosse and Dr. Badham stand pre-eminent.

Experiments of a different class, which were in the main pure *Aquaria*, had been long in operation. Such, for instance, as the *Vivarium* described by Mr. Jesse, at Hampton Court, in which many kinds of fish were kept alive and in a healthy state. This happy result, however, was accidental, and arising from the size and situation of the *Vivarium* in ques-

tion, in which plants and snails, the air-givers and scavengers, established themselves unsought, and the Hampton Court Vivarium assumed, therefore, similar conditions to those of a natural pond, and cannot, therefore, enter into the category of glass *Aquaria*, such as can be placed upon a drawing-room table; nor can its establishment be considered to interfere with the credit of the inventors of *Aquaria*, as its success was not the result of the premeditated application of a new discovery.

The successful illustration of the principles necessary for the artificial cultivation of aquatic plants and animals in small vessels, has been so splendidly exhibited at the Zoological Gardens of London and Dublin, that the taste for imitations upon a smaller scale has become quite a mania. A distinguished writer on the subject has, in fact, happily quoted a passage from Juvenal in illustration of the reigning fashion for *Vivaria* of this kind, which is exceedingly apt, though the Roman satirist referred not to little glass tanks, but to the collections of wild beasts which were so much sought after when he penned the passage—

“*Omnes tanquam ad vivaria currunt.*”

It only remains, in this portion of my little work, to say something practical of the manner of

preparing a "River Garden," or, in other words, a fresh-water Aquarium. In the first place, care should be taken that the paint and cement of the glass tank (an article of room decoration now too common to require description) should be perfectly dry, and entirely free from any unpleasant smell, which would be fatal to many of the animals, if not even to the plants also.

The layer of earth at the bottom of the tank, it is to be observed, is used more as a kind of anchorage, to retain some of the plants in their places, than as necessary to their growth; for the water is to water plants what the earth is to the terrestrial ones, and from it they take their chief nourishment. It is better, therefore, to use only cleanly washed river sand, a slight disturbance of which will not render the water turbid, as when other kinds of earth are used. Some plants, however, such as the great Water-lily, are found to do better with a layer of rich earth under the sand; but plants of that size are more suited to aquaria on a large scale in a conservatory, than to a small tank at a chamber window.

In placing a few shells, or other objects on the sand, as stays to the roots of plants that should have a fixed position, care should be taken to select such objects as would naturally be found in fresh-

water. Sea shells, or corals, so often used for this purpose, have a very anomalous appearance, and destroy the natural character of the whole arrangement.

The kind of water is not very material, if the balance of animal and vegetable life, after added, be nicely adjusted, and not introduced too profusely. A few cautions, however, are necessary. Water that has been boiled would not do; in fact, fish will live but a very short time in boiled water, because in that operation the greater part of the oxygen has been expelled from it. The water of chalybeate springs is likewise unfit, as the salts contained in it are very injurious to vegetation. River water is best, but pump or well water will answer very well, especially if well aerated, by pouring from one vessel to another before used.

The water in the tank may be occasionally aerated, also, by means of a common pair of bellows with a piece of gutta-percha tubing attached to the end of the pipe. A contrivance of this sort is adapted for all the tanks at the Dublin Zoological Gardens, with branch pipes leading to each separate tank, so that one pair of bellows aerates the whole series. The action of the air, as it enters the vessels from these tubes, is said to produce a very pleasing effect, insomuch that Dr. Ball, when he described

the apparatus at the Cheltenham Meeting of the British Association, stated that "visitors were so fond of blowing the bellows, that the curator found it quite unnecessary to employ attendants to inject fresh air into the tanks;" an amusing remark which has been repeated by Dr. Lankester.

A small hand-net is useful for occasionally removing fish or other animals; or, for more minute objects, a glass tube, to be used in the following manner:—If the thumb be placed tightly over the upper end of the tube, when about to be introduced into the water, and so held till its lower end is close to the object it is wished to take out, and then withdrawn, the water will rise into the tube itself, expelling a portion of the air, and the object may then be taken out along with the water in the tube.

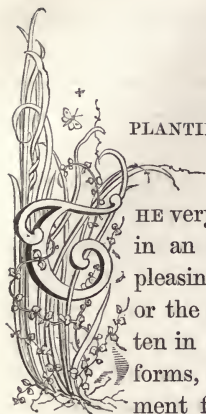
Experience, however, will best suggest many such contrivances necessary to the possessor of an Aquarium; and as they will be of more value when arising in the course of such experience, than when derived from hints thrown out in this place, I shall leave the student to make his own discoveries, in all mere matters of convenience; as he will necessarily adapt them more aptly to his own peculiar views and wants, than one who should

attempt to describe them without the special evil to be remedied immediately before his eyes. All that the teacher can safely do, therefore, is to make the student thoroughly conversant with principles, and the details will naturally follow.



CHAPTER III.

PLANTING THE RIVER GARDEN IN THE AQUARIUM.



THE very first plants placed picturesquely in an Aquarium produce an effect so pleasing that the trouble of structure, or the expense of purchase, are forgotten in a moment. The object at once forms, in fact, a most exquisite ornament for a living room, and especially a study. The cool, fresh aspect of water is always delightful; and the peculiar growth of aquatic plants, straggling in graceful spiral, or in a thousand other singular and playful forms, towards the surface and the light, are both beautiful and interesting, especially when seen as a fish would see them, that is, sidewise, and not from the top, or looking down upon them indistinctly, as is our ordinary point of view for these objects. The gentle gliding movements, too, of many of the water creatures, subsequently to be introduced, are of a soothing and placid character, that seem to fill the mind with a

sweet and lulling sensation, as by a kind of silent music. But, instead of stopping to admire the effect of the first steps in our plantation, let us first ascertain whether all the necessary conditions in the preparation of the vessel have been properly complied with.

In the first place, it should be filled with water some days before the introduction of the plants, and so long as any prismatic scum makes its appearance at the surface, the water should be changed, as that is a certain indication that the cement, or other materials used in the construction of the tank, are not, as yet, thoroughly cleansed and seasoned. When, at last, the water remains perfectly clear, then, and not before, we may begin to introduce our plants. It may be as well to observe, *en passant*, that the scum just alluded to may possibly arise from some improper materials employed in the ornamental rockwork intended to imitate the picturesque bed of the river, on which the garden is about to be planted. Any pieces of rock containing metal are bad, as are also all kinds of dross, such as clinkers from glasshouses, etc., and should be removed, if found to produce the effect described. Picturesquely formed stones, gathered from the pebbly beds of brooks or the rocky shallows of

lakes, are best. I have recently seen some very handsome pieces, brought from Loch Erne, which are of a beautifully mottled grey tone, that has a charmingly cool and natural effect in an Aquarium.

If it be intended, in addition to the purely aquatic plants, to add a few of those which, without growing in the water, love to linger on its margin, a plan which I strongly recommend, then a portion of the rockwork must be made to ascend above the surface, as shown in the circular Aquarium (Plate I.), in which two pieces of the rockery are made to project above the water, each contrived with cavities sufficiently deep to contain a supply of earth for a small group of plants.

The Aquarium represented in that Plate is one of the simplest and cheapest kind, being formed by the inversion of a common bell-glass, which is mounted upon a turned wooden stand of the simplest design. One of the projecting pieces of rockwork, the highest and driest, has been planted with a small root of Fern, belonging to the more dwarf and delicately foliated kinds. The other has been made to form the receptacle for a fine tuft of Forget-me-not—a plant which never flourishes so luxuriantly as when its roots find their way into water. Its flowers, in such a position, attain nearly

double the size they do when in a drier situation, and become so beautiful in their tender shades of delicate turquoise-blue, enamelled with their delicately small touches of white and amber at the base of the petals, that one can fully understand how the fair girl in the German legend longed for those growing out of her reach in the broad shallows of the Rhine. One can sympathise, too, with the enthusiasm of her lover, who, endeavouring to grasp them, lost his balance, and fell into the stream; being carried away by the treacherous current, still holding the coveted flowers in his clenched hand, and flinging them to the shore as he sunk, crying, "Vergeis mein nicht!"—Forget-me-not! It was the popular name—perhaps thus acquired—which probably induced one of our last Plantagenet kings, Henry V., to assume this pretty flower as his badge, instead of the Broom, which had been that of his ancestors. The name, when so taken, however, as a soldier's motto, was no longer a love-cry, but a shout of defiance; and the warlike successes of that victorious leader were such as to make the war-cry, "Forget me not!" appropriate enough when addressed to his enemies. I was about to say more upon the subject of the sweet little Forget-me-not and its associations, but space forbids.

The pretty plant growing with it, in the same Plate, is the Sundew, which delights also in damp situations. Its leaves delicately fringed with pink, and its pretty rose-coloured blossoms, combined with its general neatness of growth, make it a generally desirable plant for the Aquarium, in which, with proper care, it thrives well.

In the centre of the vessel I have placed an Arum (*Calla Æthiopica*), a plant which always flourishes best in water, forming a truly magnificent ornament for the borders of ponds, where I have seen it introduced with great success. In such situations it dies down in the winter; but protected by a sufficient depth of water, does not suffer from any degree of frost, though a very slight one is sufficient to destroy it when grown in a pot. In the Aquarium it forms a very beautiful object. The foliage rises like a column of some semi-transparent green marble through the water, spreading into a finely foliated capital above; and when the flowers eventually shoot up from this fine coronet of elegantly formed leaves, the effect is magnificent. But, even before the appearance of the flowers, there cannot be a finer central object for an Aquarium than a group of such leaves as those of the majestically graceful *Calla*. Among aquatic flowering plants,

the following will be found suitable to the Aquarium, taking care to select those of small growth for tanks of ordinary size, while all kinds may be grown with success if sufficient space be allowed, especially in Aquaria on a large scale established in conservatories, which are now becoming very general :—

<i>Alisma plantago</i>	. . . . .	The Greater Water Plantain.
<i>Alisma natans</i>	. . . . .	The Floating Water Plantain.
<i>Stratiotes aloides</i>	. . . . .	The Water Soldier, or Water Aloe.
<i>Iris pseudacorus</i>	. . . . .	The Yellow Water Iris (Plate VIII., No. 4).
<i>Hydrocharis morsus rani</i>	. . . . .	The Frogbit.
<i>Sagittaria sagittifolia</i>	. . . . .	The Arrowhead.
<i>Polygonum amphibium</i>	. . . . .	The Amphibious Persecaria.
<i>Hottonia palustris</i>	. . . . .	The Featherfoil, or Water Violet.
<i>Ranunculus aquatilis</i>	. . . . .	The Water Crowfoot.
<i>Veronica Beccabunga</i>	. . . . .	Common Brooklime.
<i>Nasturtium officinalis</i>	. . . . .	Common Watercress.
<i>Butomus umbellatus</i>	. . . . .	The Flowering Rush.
<i>Teucrium scordium</i>	. . . . .	Water Germander.
<i>Microphyllum spicata</i>	. . . . .	Water Milfoil.
<i>Tubularia aquatica</i>	. . . . .	The Aquatic Owlwort.
<i>Hippuris vulgaris</i>	. . . . .	The Common Maretail.
<i>Callitriche verna</i>	. . . . .	The Water Starwort.
<i>Ceratophyllum demersum</i>	. . . . .	The Hornwort.
<i>The Lemna tribe</i>	. . . . .	Duckweeds.
<i>Aponogiton distachyum</i>	. . . . .	The Cape Aponogiton.
<i>Potamogeton pectinatus</i> (and other species)	. . . . .	} The Pondweeds.
<i>Anacharis alsinastrum</i>		

Lastly, the most important and useful of all,
Valisneria spiralis.

To this list must be added the species of native Water Lilies, where space admits:—

<i>Nymphæa alba</i>	{ The White Water Lily (Plate II., No. 1).
<i>Nuphar lutea</i>	{ The Yellow Water Lily (Plate II., No. 2).
<i>Nuphar pumila</i>	{ The small Yellow Water Lily (Plate II., No. 3).
<i>Villarsia nymphæoides</i>	The Lily-like Villarsia.

When there is sufficient space and a certain degree of warmth, foreign species of the Water Lily tribe may be added, as the beautiful *Nymphæa cærulea*, one or two of the *Euryali* tribe, and even the giant *Victoria regia*; but as one leaf alone of this Titanic example of water vegetation would cover the space of half a dozen drawing-room Aquaria, it is in ordinary cases out of the question. The ingeniously persevering processes of Chinese gardeners might, indeed, be able to reduce the scale of this stately queen of the waters of the Amazon to such a scale as would enable them to grow it in one of their own quaintly painted miniature tea-saucers; but we have not, as yet, attained to much skill in this kind of “gardening in small.”

To these plants may be added some of the

RIVER GARDENS;

Water Grasses, which are very ornamental, and more especially the fresh-water *Algæ* and the Stoneworts.

There are also the plants growing at the margin of the water to be noted; among which the following stand foremost as among the most desirable:—

<i>Myosotis palustris</i>	The Forget-me-not.
<i>Drosera Anglica</i> (and other species)	The Great Sundew.
<i>Caltha palustris</i> (double and single varieties)	} The Marsh Marigold.
<i>Menyanthes trifoliata</i>	
<i>Pinguicula vulgaris</i> (and other species)	} The Common Pinguicula.
<i>Esquisita sylvatica</i>	
	Drooping Joint Grass.

Of such plants as may be grown on higher portions of the rockwork, rising out of the water, the following Ferns have been named by Mr. Hibberd as well suited to our purpose:—

<i>Blechnum boreale</i>	The Northern Blechnum.
<i>Polypodium phegopteris</i>	Beech Fern.
———— <i>vulgare</i>	The Common Polypodium.
———— <i>dryopteris</i>	Oak Fern.
<i>Ceterach officinaria</i>	The Common Ceterach.
<i>Lastrea spinulosa</i>	Withering Fern.
<i>Cystopteris fragilis</i>	Brittle Bladder Fern.
———— <i>Alpina</i>	Alpine ditto.
<i>Anthyrium filis fœmina</i>	Beautiful Lady Fern.
<i>Scolopendrium vulgaris</i>	Common Neat's Tongue.
<i>Adiantum capillis-veneris</i>	True Maidenhair.
<i>Trichomanes Tunbridgense</i>	Tunbridge Filmy Fern.
<i>Ophioglossum vulpica</i>	Adder's Tongue.

To these may be added the following, which I have selected from the splendid and extensive collection of Mr. Henderson, of Pine Apple Place, Edgware Road :—

<i>Adiantum cuneatum.</i>	<i>Polypodium lepidosma.</i>
<i>Asplenium attenuatum.</i>	<i>Pteris cretica.</i>
———— <i>bulbiferum.</i>	———— <i>serrulata.</i>
<i>Cassebeera hastata.</i>	<i>Selaginella denticulata.</i>
<i>Davallia solida.</i>	———— <i>inæqualis.</i>
<i>Goniophlebium neriofolium</i>	———— <i>serpens.</i>
<i>Litobrockia denticulata.</i>	———— <i>stolonifera.</i>
<i>Polypodium latipes.</i>	———— <i>Mertensii.</i>

There are also several Fern-like *Lycopods* well worthy of cultivation on the raised dry rockwork of the Aquarium, one or two species of which will thrive and grow during a year or more, by having the foot-stalks of the fronds or leaves placed in the water, and allowing the feather-like foliage to droop over the sides. A very pretty effect was produced in this manner in the Fernery of Mr. Henderson, where every information regarding the culture of Ferns and their allies is freely and obligingly given by the intelligent attendant.

In collecting wild Ferns, take in preference those found within the drip of waterfalls or on the banks of streams as most likely to succeed on the rockwork of the Aquarium. Care must be taken to

arrange plenty of drainage where you plant your Ferns, bits of charcoal, sharp sand, or rotten leaves have been recommended by Mr. Hibberd and others. The water must be prevented also from running in constantly to the roots ; a certain degree of dryness about the root is essential to Ferns ; and your Fern-ground must be constructed accordingly.

As a general principle, the water-plants do not require much, if any, soil ; as water is to them, as previously stated, what earth is to terrestrial ones, and the bed of the stream or pond only serving them as anchorage. Nevertheless, some plants, especially the Water Lilies, apparently require a somewhat strong soil to grow in. Plants of this class are, however, too large for most Aquaria, though it is stated that the *Nuphar lutea* may be grown in a vessel one foot square.

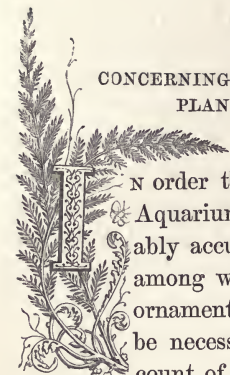
When the Aquarium has been furnished with its plants, with snails to destroy the confervoid growth on the glass, and to consume decaying vegetation, at the same time furnishing a vast number of eggs to nourish the fish and other animals in the tank, a complete circle of compensating principles may be said to have been established which impart to an Aquarium many of the permanent

qualities of a real lake. The vessel must, however, above all things, be placed where it will receive a sufficiency of light, for without that vivifying influence neither the Aquarium, nor even the natural lake itself, could carry on its interesting processes. It is in the sunshine, indeed, that some of the most beautiful phenomena involved in the creation of oxygen by the plants are exhibited, especially when the bubbles of the newly emitted gas rise quivering to the surface, displaying, with beautiful variations, all the colours of the prism.



CHAPTER IV.

CONCERNING THE CHARACTERISTICS OF THE PLANTS SELECTED FOR THE AQUARIUM.



IN order that one about to establish an Aquarium may be able to form a tolerably accurate idea of the plants, from among which he is about to select the ornaments of his aquatic garden, it will be necessary to give some further account of the most remarkable of those named in the lists contained in the last chapter.

Of the plants growing in the water, which are the most important to an Aquarium, in consequence of their aerating qualities, the first on the list is the Great Water Plantain. Its botanical name, *Alisma*, signifies a dweller in the water. When finely grown, in a favourable situation, it is one of the most stately of our water plants, and is consequently too large for a very small Aquarium; but it is remarkably handsome, and very suitable where there is sufficient room for its display. The *Alisma natans* is a swimming or rather floating water

plant. It is excessively pretty, and its white-cupped, three-petalled flowers are shown peeping above the water in Plate VIII. (No. 2). It is a plant of convenient dimensions for the Aquarium. The Water Soldier is also a plant of most manageable dimensions; and its compact Aloe-like growth and handsome white flower make it very desirable for tanks of the smallest dimensions. (Plate VIII., No. 1.) Its military name is supposed to have been given in consequence of its erect, soldier-like appearance. The pointed leaf resembling, by a stretch of the imagination, a sword, which is in fact so sharp, that it often pricks the fingers of collectors; the flower, too, has been supposed to resemble a bronze helmet, surmounted with a white plume. The roots of the parent plant must be placed firmly in the sand or soil at the bottom of the tank, from whence it will send forth runners, each of which, when it has reached the surface, forms a separate plant, which, after flowering, sinks again to the bottom and takes root in the bed of the pond or tank, to send up fresh flowering offsets to the surface, as its parent had done before it. When at the bottom of the tank, and in the under-water period of its growth, this plant gives off oxygen freely, and forms, also, a grateful shelter for small

fish ; but it must be closely watched, as it is subject to sudden decay when its treatment is uncongenial ; in which case it should be removed from the colony immediately.

A group of the *Iris pseud-acorus* (Plate VIII., No. 4,) forms a handsome central object to a tank. Its bright yellow flowers, in their season, being very attractive. Its name, the *Iris*, or rainbow, has been given to this tribe of plants on account of the great variety of rich colours with which the flowers of the different species are enriched; ranging, as they do, from yellow and red to almost every shade of blue and purple. The Frogbit, the botanical title of which, *Hydrocharis*, signifies "grace of the waters," is as elegant and beautiful as its name implies. Its flowers, of a delicate creamy white (see Plate III., No. 1), are delicately reared just above the surface, from among its purplish leaves, while its roots float downward from the plant, like slender threads, moving gently with the slightest agitation of the water. It is strictly a floating plant.

The Arrowhead is one of the handsomest of our native plants, both leaves and flowers being remarkable ; the shape of the former has, indeed, given to it both its botanical and popular English

name. The large white flowers, finely blotched with pink in well-grown specimens, appear in July, and at that season would form a grand attraction to the Aquarium (see Plate VIII., No. 3). The plants of Arrowhead might be sought in their native brooks and ditches just before the flowering season, and, as they bear removal well, they need only be allowed, like many other plants, to occupy the Aquarium during the period of their inflorescence, though it is always worthy of culture for the beauty of its leaves alone. The rhizoma, or under-ground stem, of the *Sagittaria* is very fleshy, and is used for food in several European countries.

The amphibious *Persicaria*, with its pyramidal spikes of pink-tipped blossoms, forms a very pretty object for artificial culture (see Plate VII.); as does also the Featherfoil or Water Violet. The last is indeed an exceedingly desirable Aquarium plant, its feathery leaves having a very graceful appearance beneath the surface, spreading their elegant forms about the lower portions of the tank, like plumes of green feathers, while the flowers, growing in a series of whorls, appear above the water, and have a very pretty effect, being of a delicate pinkish purple, becoming yellow towards the centre. This plant has received its botanical

name, *Hottonia*, in honour of the well-known Dutch botanist, Hotton.

The Water Crowfoot, or White Water Buttercup, should always form one of the plant-collection in an Aquarium, on account of its peculiar and interesting growth. The leaves of this plant, while they grow beneath the water, are so deeply "cut" or branched, as to appear almost fibrous in their character, like those of the class of plants which never appear above the surface. But the fibres of those leaves which are developed above the water become connected by the same kind of tissue as that which usually connects the veins of ordinary aerial leaves. In this new condition the upper foliage assumes quite a different character, and the plant has thus the appearance of being furnished with leaves of two remarkably distinct kinds.

The common Brooklime, though rather coarse in its growth, puts forth its racemes of pretty blue flowers very abundantly; and the esculent Watercress is also worthy of cultivation in the Aquarium, especially when treated in the following manner:—A few seeds should be procured, which can be purchased of any of the leading seedsmen, and sown in the bottom of the tank, where they will soon produce a very pretty green crop, over the undulations of the

sand and rockwork. The plants may be allowed to come to maturity, if thought proper, as they flourish well in such confinement; but as few will deem the Aquarium a fitting place to reap a harvest of Watercress, they may be removed after the more pleasing early stages of their growth are passed, and a few fresh seeds sown so as to continue the desirable effect.

The Flowering Rush is the monarch of its tribe; being crowned with a wreath of rosy flowers, which form the floral glory of our streams, and the chief ornament and desideratum of a river-side bouquet. I never, in the season (June and July), consider my nosegay of brook and river flowers complete without it. The plant is, however, somewhat large for Aquaria of the smaller sizes, as the leaves attain two or three feet in height, and the flower-stem rears itself high above them. Its growth, however, in confinement would be less vigorous, and as it does not occupy much space laterally, one grand towering ornament in the centre of the tank, when the situation suits, might be desirable. The botanical name of the genus, *Butomus*, signifies "hurtful to an ox," and, in fact, the sharp points of the leaves often wound the mouths of cattle when they go to drink.

The Water Germander and Water Milfoil are both manageable and desirable plants in an

Aquarium; especially the latter, for its graceful foliage beneath the surface of the water, the minute divisions of which have given to the genus the name of Milfoil, from *Millefolium*, or thousand leaves, which name, however, in its botanical sense, belongs more properly to another genus, the plants of which are not aquatic: the Water Milfoil having, in fact, for its botanical title, a Greek instead of a Latin title, *Myriophyllum*, meaning, however, the same thing.

The Awlwort is a curious little water plant, worth growing on account of the peculiar awl-like form of its leaves, which has conferred upon it its botanical name of *Subularia*, from the Latin *subula*, an awl. The common Mare's-tail derives its scientific name *Hippurus* from the Greek words *hippos* (ἵππος) a horse, and *aura* (οὔρα) a tail. It has pretty whorled leaves, but inconspicuous flowers. It has, however, been highly recommended for the Aquarium, but is not so desirable, in my opinion, as many other aquatic plants, requiring, as it does, a good depth of soil to make it flourish healthily.

The Starwort is a much more suitable plant than the one last named, both on account of the ease with which it is cultivated in a small tank, and also its curious habits of growth. The star-

like form assumed by the leaves, in the position they invariably take on the surface of the water, forming a number of very symmetrical asteriods, has given the plant its popular name—a name which might be further confirmed in its propriety, if need were, by an examination under the microscope, in which position a number of minute rosette-shaped excrescences will be discerned on the leaves, occupying, apparently, the position and functions of the hairs of other plants. It is so subject to vary in its appearance that botanists have been much inclined to subdivide the species.

The Hornwort is always introduced into lists of plants for the Aquarium, and is, perhaps, somewhat interesting on account of the horny excrescences of its leaves, from which its botanical name *Ceratophyllum*, from the Greek *ceras*, or rather *keras* (κερας), a horn, and *phillon* (φικλλον) a leaf. The plant has, however, little beauty, and might with advantage, as I think, make way for others.

The tribe of Duckweeds, however, though scarcely more ornamental than the Hornwort, have other advantages that compensate for their want of beauty. The plants of this family are said to derive their botanical name *Lemna*, from *lepis*, a scale, on account of the close scale-like manner with

which they cover the surface of still waters. In the Vivarium the Duckweeds are found of great advantage, from their peculiar habit of growth, which affords a natural screen to the animals below, when the sun is too powerful; and Dr Lankester tells us, in his instructive little work, that these plants harbour a number of minute creatures, among which the microscopist may hunt for some of his most valued game, which at the same time provides food for the fish and other inmates of the Aquarium. All that is necessary to establish a Duckweed screen is to remove a small portion of it from the surface of some neighbouring pond, when it requires no other replanting than merely throwing it into the Aquarium, where, being strictly a floating plant, it soon establishes itself and spreads rapidly. The loose pieces should, however, be picked out, as it is only in a mass that it produces a pleasing effect.

The Cape Aponogeton is one of the most desirable plants for the Aquarium, as it continues flowering nearly all the year round, and the flowers themselves, besides being very pretty, are sweet-scented. It is quite hardy, and grows with great luxuriance in our open ponds. In the Botanic Garden, in Edinburgh, and the tanks of the Zoological Society, in Regent's Park, London, this plant

has been greatly admired, and few amateurs of Aquaria, who have seen it, have failed to procure immediately a few roots for their own tanks.

Anacharis alsinastrum is another plant which, if no longer to be termed exotic, is, at all events, of very recent foreign extraction. It should find its place in every Aquarium. It has been called the New Water Weed, or, by some, Water Thyme, from its slight resemblance to plants of that class, and its history is somewhat interesting. It was unknown in England so lately as 1842, when the late Dr. George Johnston, of Berwick-upon-Tweed, noticed it for the first time in a pond, at Dunse Castle, in the month of July of that year. Specimens were sent to the Cambridge Botanic Gardens, where it grew far too abundantly, and the refuse, which was from thence thrown into the Cam, has thriven with such extraordinary luxuriance that it threatens to form a serious impediment to the navigation of that stream. From Kew Gardens it has, in like manner, escaped into the Thames, where it is already one of the most abundant and troublesome of the water weeds; while in some of our canals it positively threatens to put a stop to the navigation entirely. In the Aquarium, however, it is easily kept within bounds, and is exceedingly valuable,

not only for its graceful appearance, but also as one of the most effectual of vegetable aerators.

The *Valisneria* has the same valuable property, and its grass-like foliage is, at the same time, one of the most graceful adjuncts to an Aquarium, as shown in Plate VI., in which it is supposed to be a central object, round which gold fish are sporting in the enjoyment of the grateful shade it affords. The *Valisneria* and *Anacharis* have a pretty effect grown together, and are the only plants (attended by a few fresh-water mollusca) necessary to an Aquarium in which a few choice fish only are kept. *Valisneria* is named after the Italian naturalist Valisnei, who wrote on insects and plants in the last century.

The Water Lily tribe have been described in another place, as also the ornamental Water Grasses, and we now come, therefore, to a series of water plants of a lower range in the scale of vegetation, though not less curious and interesting.

These consist of a class of fresh-water vegetation analogous to the sea-weeds of our coasts, and also of another family, consisting of two genera of plants only, *Nitella* and *Chara*. These two genera contain, however, some pretty vegetable forms. The *Flexile nitella* may be known by the

branched character of its stems, and its smooth, pellucid appearance. The *Chara Hedwegia* and *Chara hispida* are both very elegant, and their somewhat angular forms would afford an agreeable variety to the other vegetation. Their presence is indicated in the plate of fish. (Plate IV.)

Of the fresh-water *Algæ* the most interesting sections are, perhaps, the Quiverworts, or *Oscillatoria*, the singular movements of which have led to many conjectures and to much discussion among learned naturalists. They have been thought by some to form, in fresh-water, the same link between vegetable and animal life as that of some of the lower order of marine *polyps*. In short, the subject is so attractive, that I make no apology for introducing here the interesting paper on the subject read by Professor Knowles, of Birmingham, at the late meeting of the British Association at Cheltenham :—

“ ON THE OSCILLATORIÆ, BY PROFESSOR KNOWLES,

“ OF QUEEN’S COLLEGE, BIRMINGHAM.

“ The *Oscillatoria* belong to a group of plants which seem to stand intermediately between the animal and vegetable kingdoms.

“ With regard to the extraordinary movements observable in this interesting family of *Algæ*, I have

not hitherto met with any explanations that appear to me to be satisfactory.

“Dr. Hassall, in his work on the *Fresh-water Algæ*, observes, that he can perceive nothing extraordinary in these motions; nothing indicative, as most suppose, of a sensitive or animal life. He then goes on to state that the *Oscillatoria* are naturally straight; that the act of placing them under the microscope must, of necessity, bend them; and that the motions that are then perceived are nothing more than a return to their naturally straight position, depending upon their elasticity. He further states, that currents almost imperceptible in the liquid in which they are immersed, and perhaps unequal attractions amongst the filaments themselves, are causes amply sufficient to explain any motion which he has ever witnessed amongst the *Oscillatoria*.

“This appears to me to be a very easy, but unsatisfactory mode of disposing of a difficulty; in short, it is an opinion that is evidently the result of hasty or insufficient observation.

“Now, I have no hesitation in stating that, after very careful and repeated examinations, I have fully satisfied myself that the motions of this family of fresh-water *Algæ* are entirely independent of any

electrical influence ; of any current in the fluid in which they are placed ; or of any effort to recover their straight position. The movements, in fact, have very much the appearance of being spontaneous ; an opinion in which I am pleased to find that Captain Carmichael fully concurs. The late Captain Carmichael devoted his attention for many years to the investigation of marine and fresh-water *Algæ*, and his opinions upon this subject are consequently entitled to the highest respect.

“Many of the larger *Oscillatoria*, if carefully examined, may be seen to move in various directions—sometimes to the right, sometimes to the left, sometimes slowly, sometimes briskly. I have, however, never perceived in them anything like an effort to recover the straight position which is considered natural to them. On the contrary, they may often be observed to bend gradually, so as to form a very considerable curve ; return again to the straight position ; and then bend in an opposite direction. They have also a progressive motion ; and two filaments, lying side by side, may frequently be seen advancing in opposite directions on the field of a microscope. This progressive motion, in all probability, is effected by means of *cilia*, although I have not hitherto been able to detect them.

“Of the correctness of these facts any one may readily convince himself by examining, with a little attention, fresh specimens of any of the larger *Oscillatoria*.

“The evidence which I have adduced on this subject is sufficient, I presume, to prove the fallacy of Dr. Hassall’s views.

“Closely allied to the *Oscillatoria* is the genus *Spirillum*, the motions of which are equally remarkable. Some time ago I met with one which may, possibly, be new, as I do not find it to agree altogether with any species described either by Dr. Hassall, or any author to which I have been able to refer. It comes nearest to *Spirillum Jenneri*; but Dr. Hassall has not seen that species with more than eight or ten spiral coils; while the specimens I am alluding to have often fifty or sixty spires, and occasionally nearly 100.

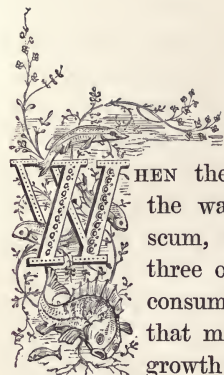
“I have usually found it mixed with various species of *Oscillatoria*. Its motions are occasionally very active, and are very like those of the larger *Oscillatoria*, except that, in advancing across the field of the microscope, the movement is distinctly spiral. I have also very often seen two of them entwine with each other, and thus present a beautiful chain or cable-like appearance.”

After the reading of the foregoing paper, it was remarked by Professor Balfour that the motions in question might be the result of the growth of the cells of the plant; but Dr. Lankester considered them entirely owing to the proteinaceous protoplasm within the cell, a matter which, both in plants and animals, is known to possess a contractile power. It was the source of the movements in the *Protophyta* and *Protozoa*, and might be regarded as containing the essential elements of a nervous and muscular system. So far Dr. Lankester's argument agrees with the theory of Professor Knowles; but he omitted to state whether he considered the movements voluntary or not, so that this interesting physiological question is still an open one.

It will be seen, from these observations, that the keeping of an Aquarium should always be accompanied by the possession of a microscope, with the aid of which it is evident that an abundant, curious, and instructive course of investigation need never flag, while the inmates of the tank are kept in that flourishing condition, which a proper attention to the principles upon which it is founded cannot fail to secure.

CHAPTER V.

THE MOLLUSCA AND THE FISH.



WHEN the plants are well established, the water not forming the slightest scum, and the tank furnished with three or four common Pond Snails to consume any decaying vegetation that may occur, and keep down the growth of the *confervæ* which would cover the glass, and render the spectacle of its inmates imperfect, then the Aquarium is ready for the reception of the fish ; which, from their graceful forms and agile and pleasing movements, are always the greatest favourites.

Previously to describing the fish most suitable for our purpose, we may derive some entertainment and instruction from the examination of the family of shell-bearing mollusca of our fresh waters, whose services as scavengers are so important in the circle of compensating principles, upon which the establishment of the Aquarium is founded. The common Pond

Snail alone has been found to fulfil these functions with great completeness, but as variety of form is a great desideratum when it is sought to render an Aquarium an ornamental object, several other kinds of fresh-water mollusca may be added. The Trumpet Snail, with its flat coiled form, similar, in miniature, to that of the giant *Ammonites*, so remarkable among the shells of a former epoch of the world's natural history, will, for instance, form a pleasing contrast to the sharp spiral of the shell of the *Limneus pereger*, or small Mud Snail. Then there is the beautiful though common Marsh Shell, *Paludina vivipara*, and its relative, *Paludina achatina*, both of which would be ornamental as well as useful. These species only attack the small decaying portions that fall from the plants, or the minute confervoid growth that attaches itself to the glass. But some other species are very destructive to the plants themselves. Among these the larger Mud Shell, *Lymneus stagnalis*, is most voracious in an Aquarium, and a couple of them would soon clear it of its little forest of aquatic vegetation. Some of our bivalves of the fresh-water Mussel tribe may be added, for variety of form, though it is not yet ascertained whether they are useful as cleansers. Among these the Swan Mussel (*Anodon cygneus*) is

interesting on account of its large size and agreeably tinted semi-transparent shells. The British Pearl Mussel (*Alasmodon margaritiferus*) might also be introduced. Pearls are occasionally found in all the fresh-water Mussels, but most frequently in the last-named species, being generally caused by the accidental presence of some small irritating substance within the shell, which cannot be expelled, and which is therefore coated with layers of the same substance as that which forms the nacreous lining of the shell itself. The artificial introduction of such substances has been tried with success, but not with sufficient certainty of result to be of any commercial importance. The pearl fishery in some of our British streams was, however, at one time followed with such perseverance as, no doubt, rendered the trade in them to some extent remunerative, and in the time of the Romans they were sent to Italy in considerable quantities. Antiquarians have collected many interesting particulars concerning this traffic, which we have only alluded to *en passant*. There are many other varieties of British fresh-water shells which might be introduced with advantage into the Aquarium, but I must refer those who would make them a prominent feature in the tank, to the beautiful and

complete works on our British fresh-water shells, such as those of Turton and others.

The cleansers having been duly located to keep the apartment in order, like the *neokorio* of the celebrated temples of Greece, the fish may be introduced.

I shall speak of Gold and Silver Fish in a separate place, and commence my description of the British species suited to our purpose with the Perch. (Plate IV., No. 1.) He is a fine fellow, and we should take care to make his acquaintance, and know something about him before requesting his company in the little glass palace to which he is about to be invited. Baron Cuvier, in his great work, has chosen the common Perch as the type of his order, *Perca*—an honour to which his finely marked characteristics fully entitle him. His distinct markings, his strikingly erect dorsal fin, and fine bold movement in the water, early attracted the notice of ancient as well as modern naturalists, and we thus have him accurately described under the name of *περκη* (*perké*) by the great Greek physiologist Aristotle. He was the *Perca* of the Romans, as Mr. Yarrell tells us in his beautiful work; and his ancient name has been but little mutilated in his modern titles. *Pergesa*, in Italy; *Persche*, in Germany; *Perche*, in France; and more briefly *Perch*, in England.

This handsome fish is found in nearly all the lakes and rivers of temperate climates, but in the colder regions, towards the north, he becomes rare, and at last disappears. Even in the lochs north of the Forth he is but sparingly found, and entirely wanting in the more remote lochs of Scotland. Yet his distribution is somewhat capricious, for although he is not found in Orkney or Shetland, he is described by Nellson as not infrequent in Scandinavia.

The Perch, if not of too large size, in which case he would be dangerous to his neighbours, is exceedingly well suited to the Aquarium, both on account of his robust constitution, and his susceptibility of being tamed, to say nothing of his handsome appearance. Mr. Jesse, in speaking of Perch placed in a Vivarium in Bushy Park, says, that after becoming familiar with their new mode of life, they came up boldly and took worms greedily from the fingers. This fish is, in fact, one of the most fearless of his tribe, and his rashness often proves his destruction, for he is generally the first prize of the young angler. Perch have been known to breed in small vases, and there is little doubt that they might, with only ordinary care, bring up a numerous family in a well-managed Aquarium. They are so hardy that they live for many hours out of water,

and revive when put in again without appearing to have sustained much injury. In Catholic countries, indeed, where fresh fish is much more prized than with us, fine Perch are often brought to market and exposed for some hours on open stalls, upon a little damp moss, and if not sold, taken back, and put into the pond again. The Perch frequently attains four pounds in weight, or even more. Donovan, in his "History of British Fishes," says they have been taken from Bala Lake weighing five pounds; and it is stated by Yarrell, that a gentleman residing near Dudley took one six pounds in weight from the Birmingham Canal. Colonel Montague records the capture of a Perch of still greater size, stating that one was taken in the Avon, in Wiltshire, with a night-line baited for a Pike, which weighed eight pounds; dimensions which Pennant's famous specimen considerably exceeded, the one he records as taken in the Serpentine, weighing nine pounds! This must have been a magnificent fish; but it is stated by Block that a head of a Perch is preserved in the Church at Luehlah, in Lapland, measuring near twelve inches from the nose to the gill cover. This, however, must doubtless be the head of some allied species, and not our common Perch; probably the last of some now extinct species.

The colouring of a healthy and well-marked Perch is very striking. The back and upper parts are of a rich olive-brown, variegated by several broad bands of a dark purplish hue. These upper tones pass into rich golden tints, which grow gradually paler till they become nearly white underneath. The ventral, anal, and caudal fins are bright vermillion, the others, different shades of brown, the dorsal one being marked with a few black spots.

Specimens of the Perch are occasionally found nearly white, in ponds impregnated with the particles from particular soils; and they retain this colour even when removed to other waters. A white Perch would form a splendid addition to the Aquarium, but such a prize is but rarely to be met with. It should be observed here that fish placed along with the Perch should be of nearly or quite his own size, as he is terribly piscivorous.

I stated, in reference to the Perch, that it was desirable to know something of his character and antecedents before introducing him into the Aquarium. The same remark applies in like manner to the other fish recommended for that purpose, as the more we know respecting their habits, qualities, history, etc., the more we shall find them surrounded with pleasing and instructive associations,

and capable of inspiring many kinds of interest which we should not have dreamt of without some previous knowledge concerning them. I shall therefore make no apology for appending a brief historical notice to each of the fish about to be described.

The Carp is a desirable fish for the Aquarium—perhaps even more so than the Perch, as he is not so voracious; indeed, he seldom attacks fish, living almost entirely upon small aquatic insects or worms, etc. The common Carp, *Cyprinus carpio*, was noticed by both Aristotle and Pliny, but was not held in so much estimation by the ancients as by the moderns, especially during the middle ages.

The Carp declines in size when removed from the warmer regions of the temperate zones; but he is “cultivated” as a table delicacy with much success both in Austria and Prussia, where Carp ponds form an essential feature in rustic economy. An acre of water stored with Carp will, in fact, let for as much as an acre of the richest land. In central Europe, where it is difficult, indeed nearly impossible, to obtain sea fish, those of the fresh-water are very highly prized, and their growth and various methods of fattening them have been studied with much success.

From the custom of keeping them in artificial ponds, the great age to which a Carp will live has been frequently noticed, and there are several cases recorded of their living for a 100 and even 150 years. The celebrated tame Carps of the ponds of Fontainebleau are, indeed, said to have been placed there in the reign of Francis I., which would give them a much greater age. It is said, however, that after a certain time they lose the golden hue of their scales, which assume an ashy tone, by which their advanced age may be known.

Mascal claims the credit of having introduced Carp into England, but they were certainly known before this time, if, indeed, in our southern waters they are not indigenous. In the curious book of Dame Juliana Berners, prioress of Sopewell Nunnery, called the "Boke of St. Alban's," and printed at Westminster in 1496, by Wynkyn de Worde, the Carp is mentioned as "a deyntous fish;" and in the privy purse expenses of Henry VIII., for the year 1532, various sums are entered as paid to persons for bringing Carps to the king.

The Carp loves sluggish rivers, especially when the bed is formed of soft mud; but he grows much more freely in some waters than others, without any apparent cause. In Scotland Carp grow very

slowly, and it is said do not breed at all. They live for a great length of time out of water if kept moist with damp grass or moss, and are often suspended in that way in the dairies in Holland, and fed upon bread and milk, under which treatment it is said they fatten very quickly, and the flesh becomes exceedingly delicate. In ponds they feed well on boiled potatoes, and have been known to attain to three pounds in weight as early as their sixth year.

They attain, occasionally, a remarkable size even in England, though not so great as in some parts of the Continent. Mr. Ludbrooke, from his park at Gatton, as we are told by Yarrell, presented Lord Egremont with a brace that weighed thirty-five pounds; while at the fishing of a larger piece of water, on another estate, a Carp was found thirty inches long, and weighing eighteen pounds.

Aristotle calls the Carp *κυπρινος*, which Pliny translates *Cyprinus*, the name by which the genus is still known in scientific natural history. His popular names have, however, for a long period been *Carpeno*, *Carpo*, *Karpfen*, *Carpe*, or *Carp*. It is said that the Carp was originally introduced from Persia, and became distributed in Europe by degrees.

I have mentioned the fine Carp in the ponds at the Chateau of Fontainebleau; and M. Orbigny* mentions others as fine, and probably of as great age, at Chantilly and Pontchartrain. The Carp in the Dniester and Volga attain to a very large size, not infrequently weighing as much as seventy pounds.

The Crucian Carp, *Cyprinus curassia*, by the French termed *Carpe carassin*, and in Sweden, *Carussa* or *Carouche*, is another species, generally of inferior size, which is well suited to the Aquarium; as is likewise another distinct species, the Prussian Carp, *Cyprinus gibelio*, which is a very hardy fish, and it is said will live for thirty hours out of water.

Our old favourites, the Gold and Silver Fish, are of the Carp family (*Cyprinus auratus*), but I shall speak of them separately in another place.

The Tench (Plate IV., No. 2,) is also easy to keep in a moderately sized glass tank. His fine deep bronze tones, touched here and there with a sparkle of gold at the edge of the scales, as though brightened by his passage through the water, give to him a richness of hue that produces a good effect among the foliage of the tank; while his small and delicate scaling forms a remarkable contrast to the large horny scales of the Carp. In the

* See Hist. Nat. vol. iii.

Aquarium at the Zoological Gardens there are several Tench, which appear to enjoy themselves as well as in their native ponds. They generally lie near the bottom, as though in a dreamy and pleasing abstraction, but if too closely watched glide mysteriously away and disappear, taking advantage of some deep shadow, or projecting stone, or tuft of *Valisneria*. Like the Carp family, the Tench is very tenacious of life. Daniel, in his "Rural Sports," mentions a curious example of this tenacity under very peculiar circumstances. A pond had been filled up for many years, when it became necessary to clear away the ground below the depth of the former pond. On the last portions being removed, it was found that the mud at the bottom had never thoroughly dried, and there were a few holes imperfectly filled by the rubbish, which still contained a small quantity of water. In these cavities several Tench of large size were found in perfect health. Their habit of hybernating in the mud having made this long interment only appear, it would seem, like a somewhat unusually long winter. Under the roots of a buried tree a larger hole than the rest contained rather more water, and in this an immense Tench was found, which had grown to the form of the hollow which had so long been his

prison, and could not be removed till the roots were cut away. This singularly shaped creature was perfectly healthy, and remained so after being removed to an ordinary pond, where he continued to flourish at the time that Daniel wrote his account of the circumstance, which was some years after the removal of the monster Tench to his new abode. The Tench is a good table fish, but is sometimes unpleasantly flavoured by the presence in the pond of some rank weed. This kind of susceptibility is, however, very capricious; for occasionally Tench, which were positively stained black by the mud of the waters in which they have been bred, have been found perfectly sweet, while those taken in much more favourable situations have had a muddy or earthy taste, which is a very common objection to the flesh of the Tench. This forms no obstacle, however, to the adoption of the Tench as an inmate of the Aquarium, and only refers to his eligibility for the fryingpan or gridiron.

The Roach, *Leuciscus rutilus* (Plate IV., No. 3), is a very pretty fish. His white scales glisten like silver, against which the bright red fins are seen to great advantage, giving him that bright, sparkling, healthy appearance which perhaps led to the saying, "as sound as a roach." This may have

arisen, however, from his French name, *Roche*, that is, *rock*; and “sound as a rock” may possibly have been the original form of the saying. But as the Italians have a proverb, “*sano come il pesca*” (sound as a fish), it seems that we may leave the English form of the same idea, “sound as a roach,” undisturbed, for it is certain that he always looks positively gleaming with bright fresh health; the vivid orange circlet of the eye and the ruddy fins tending to increase that pleasing impression.

Roach of from a quarter to half a pound are considered by the angler fine fish, quite above the usual run; but Pennant refers to Roach of five pounds in weight. Jesse states that the largest ever taken in the Thames weighed three pounds; and old Izaak Walton tells us, in his quaint way, that he considered a Roach of two pounds worthy of “particular attention.”

The Pike (Plate IV., No. 4), may be added to the Aquarium without danger, if space should allow; but he must be a small specimen, not much larger than the Roach, or the latter would stand but little chance of exhibiting his personal charms for a very lengthened period. The Perch, the Carp, the Tench, and the Pike should, in fact, be selected of as nearly the same size as possible. Taking away

the Pike and Perch, the others would agree well together, of almost any size, as they are not voracious—at all events in a fish-devouring way—and are content with much smaller prey. If, however, variety be sought—and certainly the elongated figure of the Pike and the fine dorsal battlement of the Perch add greatly to the diversity of the forms and characters of a group of fish in an Aquarium—then the caution just put forth must be carefully observed.

The Barbel (*Barbus vulgaris*), a name suggested by his seeming beard, will also do well in confinement; but he is rather a clumsy-looking fish, and also somewhat sluggish in his movements. He is represented, though upon a very small scale, in Plate I. Jesse mentions Barbel among the fish kept in the Vivarium in Bushy Park, stating that they were the strongest and most untameable of all the kinds. In spring, however, when they could perceive no one watching them, they would sometimes roll about and rub themselves against the brickwork, in many playful gambols. In the Thames they sometimes attain the weight of fifteen pounds. They become quite torpid in winter, sheltering themselves under some projecting bank, or sometimes under the lee-side of

a stationary barge, where they occasionally congregate in large numbers, lying one over the other. This state of torpidity becomes so complete in the depth of the winter, that they may be taken by the hand without making any attempt to escape.

The Flounder may be placed either in a fresh or salt water tank, as he frequently ascends our rivers, sometimes not finding his way back to the sea. His singular action in swimming is so distinct from that of the kinds of fish more frequently observed, that it forms an agreeable variety in the Aquarium. It is from its peculiar action when swimming, near the bottom, that the Swedes give this fish the name *Flundra*, from which the English name is derived.

Another kind of swimming action may be exhibited by the introduction of an Eel or two to the collection, care, however, being taken not to overstock the colony; for it is said that two small fish and as many aquatic plants are enough for each gallon of water. The sharp-nosed Eel (*Anguilla acutorostris*), and the broad-nosed species (*A. latirostris*), are equally common. Both belong to the Lamprey tribe, Cuvier's *Muraenidæ*, or eel-shaped fishes. The specimens selected should be small, as large ones have been known to devour small-sized

Gold fish. They are torpid in winter ; and it is their habit to make their way to the sea to spawn towards August, when they will leave the ponds and travel for miles over the meadows to reach their destination. At the time that the young fry ascend the rivers towards the fresh waters, vast shoals of them have sometimes been observed. The passage of young Eels up the Thames at that season, as Yarrell informs us, is an extraordinary sight. Above 1800 per minute, averaging about three inches long, have been known to pass a given point. This passage of the young Eels, says the same writer, is called Eel Fare, from the old Saxon word, to travel, or pass. From this migratory habit it is evident that at a certain season the pet Eel will escape from the Aquarium, and most likely come to some untimely end, unless the requisite precautions be taken.

Among the smaller kinds of fish, I have tried the Loach, or Beardie (*Cobitis barbatula*), in an Aquarium, and found the species bear confinement well. It would be worth while to observe very carefully the movements of this little fish, as it is said that by them the changes in the weather may be ascertained as readily as by a weather-glass. At certain periods I have, indeed, noticed that it

becomes restless; and its popular name, Loach, or Loche, is derived from the French verb *locher*, to be uneasy. A continental species, the lake Loche, is in an old naturalist's miscellany termed the *Thermometrum vivum*; and it is certain that they are extremely sensitive to atmospheric changes, as thunder frequently kills them. The Loach is not altogether solitary in this extreme sensitiveness to change of weather, for the Gold Carp frequently die in large numbers during thunder-storms; and Lobsters, as Pennant tells us, sometimes cast their claws at a loud clap of thunder. It has also been observed that the high swimming fish are less affected by electric changes than those that swim near the bottom. The Loach, considered by us as an utterly insignificant fish, is considered a choice table delicacy in Sweden, where it was naturalized by Frederic I. as a table delicacy.

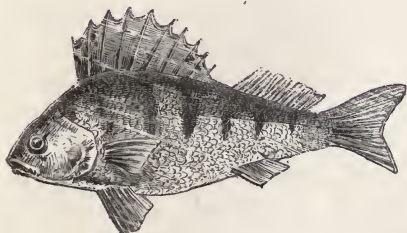
The Gudgeon (*Gobio fluvialis*) holds a more conspicuous place among our smaller native fishes. The tones of purplish green which decorate his back are very pleasing, and, in some individuals, of remarkable richness, and he occasionally attains the length of eight inches, though seldom exceeding four. Three or more should be kept, if any, as they are accustomed to swim in shoals, and a phalanx of

these little fish swimming about the Aquarium, in company, produce a pleasing effect.

The Miller's-thumb, or Bull-head, would form a curious and interesting object in the Aquarium, but that he has the habit of concealing himself under stones or any other shelter he can find. In Switzerland children watch for them and spear them as they attempt to dart from the shelter of one stone to that of another. It is considered delicate food in Italy, as we are told by Rosso; and in Russia it is used as a charm against fever.

The Minnow, *Leuciscus phoxinus* (Plate IV., Nos. 5 and 6), is one of the very smallest of British fish, but he is a very elegant little fellow. His motions, are sprightly and agile in the extreme, and when the sun shines upon the tank in which he is placed, the fresh olive-green of his back shading to silvery white beneath, has a very glittering effect as he darts playfully about. In summer the white portion of the body is delicately tinted with rose colour, which has doubtless given to him one of his popular names, the Pink. The name Minnow, however, or, more correctly, Minim, is no doubt derived from the Latin word *minimus*, as he is, in fact, one of our smallest fresh-water fishes. But there is one native genus of still smaller dimensions,

the *Gasterosteus*, or Stickleback, whose habits are so interesting that it would be well worth while to assign a tank especially to his service; and in that feeling I shall devote an entire chapter of this little book to his history.



CHAPTER VI.

STICKLEBACKS AND THEIR NEST-BUILDING.



OME of the pleasantest associations, bound up with the recollections of my boyhood, are those connected with my excursions for the capture of Sticklebacks. All the scenes of those days of sunshine are still green in my memory, and even the very names of the obscure streamlets and lanes have a sound more intimately familiar than things of yesterday. Sparkbrook, Stoney Lane, Lady-pool Lane, Great Mill, are names still attached to the reminiscences of days of peering into the mysteries of the world beneath the waters, and into the life and movements of half-hidden creatures, whose instincts and habits possessed an irresistible attraction which I could not resist.

More than once I was on the point of making the interesting discovery concerning the nidification, which M. Coste has had the gratification of adding to the archives of Natural History. I had seen the male Stickleback darting hither and thither, with a

small bundle of some green substance in his tiny mouth, but, with all my watching, failed to discover the purpose for which it was intended. But before describing this interesting discovery, which, with proper care, may be illustrated in a well-arranged Aquarium, let us become more intimately acquainted with the little creature, whose parental instincts in the matter about to be described would seem to place him far above all the larger kinds of fish, as well of fresh as salt water.

The Stickleback (of the genus *Gasterosteus*) is, as we shall see, a most interesting little fellow. He is found along our coasts as well as in our inland streams, and is, therefore, suitable either for the marine or fresh-water Aquarium. He is possessed of muscular strength which seems far beyond his small dimensions; and he displays his powers not only in combats, often fatal to one or more of the contending parties, but also in playful gambols, often leaping above a foot out of the water when excited to more than usual joyousness by the genial warmth of a summer's afternoon. He might escape in this way from an Aquarium and perish, if no protection were placed over the tank, which is a precaution desirable on many other accounts. His natural food consists of small insects, chrysalids, and young fish just

emerging from the spawn. He is very ravenous, and it is stated by Baker, as quoted by Orbigny, that one individual has been observed to devour seventy-four *vaudoises* within an hour. In some parts of the Continent the Sticklebacks are so abundant, after their spawning season, that they are used for manure, and pigs are fed with them. In eastern Prussia oil is extracted from them; and the Kamtschadales dry the *Gasterosteus obolarius* in large quantities for the winter food of their numerous dogs. In England also they are, in some seasons, almost equally abundant. At Spalding, in Lincolnshire, Pennant informs us that they appear occasionally in such large numbers, that he recollects a man who earned four shillings a day by selling them at sixpence a bushel. These shoals at Spalding appear every seven or eight years, coming up from the Wellan. Their flesh is of an agreeable flavour, and forms very wholesome food, making an exceedingly nutritious broth; but their diminutive size has secured them against becoming very generally articles of human food. Their cuirass-like armour and spines secure them also against the assaults of other fish, even the most voracious; but they have a fatal enemy in a small crustaceous parasite, which attaches itself to their bodies, and, sucking the blood, soon destroys

its victim. They are also pursued and devoured by the voracious Water Beetle (*Dyticus marginalis*), whose horny forceps defy the armour and spinal defences of this formidable little fish.

Block states that the duration of the life of the Stickleback is three years ; and the observations of other naturalists appear to confirm this opinion.

Mr. Yarrell divides the genus *Gasterosteus* into several species, all of which are tolerably well marked. The first is termed *G. trachurus*, or Rough-tailed Stickleback; his defensive plates of armour continuing all along the side to the tail, upon which they appear to terminate in minute spines. The second is called *G. semiarmatus*, or half-armed, his defences not continuing above three plates beyond the pectoral fin. The third, *G. leiurus*, or Small-tailed Stickleback, the side plates being less conspicuous and not extending beyond the pectoral fin. The fourth, *G. brachycentrus*, or short-spined kind, as large as the first or second species named, but having the spines on the back much shorter. The fifth has been termed *G. spinulosus*, the four-spined species, much smaller than the last named. Probably from feeling himself more completely armed, however, he is more decidedly pugnacious than his larger relatives, even in confinement. The

last of the species frequenting the fresh as well as salt water is *G. pungitius*, the ten-spined Stickleback, a very distinct species, much smaller than any of the preceding. Cuvier makes a second species in the ten-spined division; but it is not found in England. There is, however, one more native kind, the fifteen-spined, which remains always in the sea, but, like its relatives, will live in fresh water. If, therefore, it can be procured, it should be present, to complete the collection of native species in an Aquarium, for which purpose I would recommend preparing a special tank, which, considering the interesting habits of this pretty tribe of miniature fishes, would well repay the trouble. The last-named species, though a thoroughly well-characterised *Gasterosteus*, is of very peculiar form, almost Eel-like in his proportions, from which it has been termed the Sea Adder. Mr. Yarrell gives a very interesting account of the capture of a specimen of this rather rare species, in the stomach of which he found a specimen of the curious Opossum Shrimp, which he had never seen before. The peculiarity of the Opossum Shrimp, as described by Montague, is that the female is furnished with a natural external pouch, like that of the Opossum or Kangaroo tribe, in which she carries her ova and afterwards her young.

It is composed of four concave scales turned upwards; and the opportunity of observing this curious creature was deemed, by the enthusiastic naturalist I am quoting, a more interesting event than even the capture of the fifteen-spined Stickleback itself. The first three species of Sticklebacks, just described, have been considered by some as merely accidental varieties; and none of these ever exceed two and a half inches in length.

Some of the habits of these interesting little fish are very graphically described by a writer in Loudon's "Magazine of Natural History." A number being placed, as he informs us, in a wooden vessel of considerable size, at first swam about in a shoal, as if exploring the nature and capacities of their new habitation. Suddenly, one of the party took possession of a particular corner, and succeeded in beating off his companions from that part of the domain. First, however, a furious battle ensued, the combatants swimming round each other, fencing with the utmost skill, each watching for an opportunity to dash at his opponent with his sharp spines fully extended, or failing such an opportunity, resorting to the warfare of the mouth. Such a contest frequently lasts several minutes before either gives way. When one at last retires,

beaten by sheer exhaustion, he is followed by the conqueror, who chases him till himself unable to pursue. Many such contests, however, terminate fatally in the early part of the onset, fatal wounds being at the first furious passes inflicted with the spines. These, however, I am happy to say, are the habits (as we are informed) of the male fish only, the females being quite pacific and never interfering in these sanguinary conflicts.

They are indeed always without the gaudy and soldier-like uniform of the male, which in summer is bright with glowing scarlet on the chest, while on the back shades of rich purple are often found, beautifully blending into green and white. In combat they appear to have the power of assuming their brilliant colours, as Indians do their war-paint, and during the contest the little scaly warrior is refulgent with scarlet, vivid green, and white. If conquered, however, his war-paint fades to the dullest hues, while the victor swims triumphant, and still splendid in his gaudy uniform. If fatally wounded, the defeated hero, in his latest agony, once more assumes his splendid colouring (but not so brightly), as though in his last delirium he fancied himself the conqueror.

In this power of changing colour the Stickleback

is quite chameleon-like. The conqueror in a combat, from being a speckled dull greenish-looking fish, assumes the rich colouring described, which varies according to varying circumstances. The belly and lower jaws frequently becoming brilliant crimson, and the back sometimes white, or a beautiful cream colour, but more frequently a fine clear apple green.

These fish, indeed, vary much even in their ordinary colouring, some being very nearly black. The little sable warriors, however, only become blacker during a combat, and somewhat paler if defeated.

The effect of passion upon the colouring of this tribe is strongly illustrated by the existence of a similar power in the marine species, the fifteen-spined Stickleback. This pretty fish is of a fine full olive on the back, becoming rich golden beneath; but from sudden terror it has been known to turn to a pale dirty white for eighteen hours, afterwards regaining its usual colour.

This singular kind of susceptibility in the Stickleback may be curiously illustrated by placing some of the most brightly coloured in a white vessel, in the dark, when they quickly become nearly white, regaining their colour when exposed in an ordinary vessel to the light. It is said they will assume, in a greater or less degree, the colour of any vessel in

which they are placed, and that their natural colours are frequently the result of the colour of the soil forming the beds of their native streams. A similar kind of susceptibility is also found in other fishes—a circumstance which is, in fact, a means of defence, as rendering them less conspicuous in the water. Dr. Stark tells us that he once observed a shoal of Flounders, on the flat sandy part of the coast of Holland, so exactly the colour of the sand over which they were swimming, as to be hardly distinguishable from it.

But I must hasten to describe the most interesting instincts that honourably distinguish the little Stickleback. I of course allude to those connected with his habits of nidification.

Nest-architecture is generally thought to be almost entirely confined to birds; the number of quadrupeds which attempt nest-building being very few, and those few not remarkable for any special skill. Indeed, even in these cases, such as the “nest” of the Squirrel, the Field-mouse, the Rabbit, and a few others, it is rather a “bed” for the young, than a receptacle for the deposition and production of eggs, which is alone the character of a true nest.

The only true nests, therefore, except those of birds, are constructed by fish. This, consider-

ing the apparently insufficient means which their formation has furnished them for the edification of such structures, appears very extraordinary, and yet, if our means of observation presented greater facilities, many more species of fish might be found to be constructors of complicated nests, than those which are as yet known to possess that instinct. The veil of the waters, however, which screens their habits so effectually from us, renders discovery in this direction exceedingly slow.

Till M. Coste read his interesting paper, on *The Nidification of the Stickleback*, the other day, at the French Academy, modern naturalists, speaking generally, may be said to have been ignorant of this peculiarity in any species of fishes, as no published details had appeared. It had been singularly overlooked by them that Aristotle, above 2000 years ago, had stated that a certain little fish had the habit of constructing a nest like that of a bird.

Clive, it is true, among modern naturalists, had asserted that the Black Gobie built a nest, and it is now thought that this is the same fish alluded to by Aristotle. Major Harding had also stated that the Gourami, an Indian fish, constructed a kind of nest; but no accurate details upon the subject were made known before the publication of the interesting

paper, above alluded to, by M. Coste, entitled “*Sur la Nidification des Epinoches.*” It is, in fact, these curious details so recently published concerning the habits of a little fish found in every streamlet, which has at length called the attention of ichthyologists to this interesting subject.

Among birds, as we well know, the female is the chief architect, the male only assisting in bringing material; but among fish it would seem that the building of the domestic dwelling is the task of the male. The female, or rather females—for the Stickleback is a polygamist—do not appear to offer any aid at all, and expect their lords not only to do all the fighting, as previously described, but also all the work; while the wives remain idle, in a kind of fine-ladyism, which the male Stickleback appears, in his polite devotion to the sex, entirely to approve of.

At spawning-time, therefore, the males may be observed, one and all, very busy in preparing the nursery, an evidently arduous task to each little architect, who brings all the materials in his mouth, of course in very small quantities at a time, and frequently from very considerable distances. It is very instructive to observe his contrivances for preventing the foundation of his structure from being carried away by the stream, which he effects

by bringing sand, also in his mouth, and placing it upon the successive layers forming the foundation of his edifice. His next process is to cement these layers well together, by a gluten which he obtains from his own skin, by rubbing himself against them; and thus is formed the floor upon which the rest of the structure is to be raised. It is occasionally further secured at its anchorage by a root or twig at the bottom of the stream, or by some other accidental assistance.

His next process is to stick small, or occasionally stronger materials, as uprights, all round the foundation; frequently taking them out with his mouth, and putting them in situations more to his fancy, till he is at length satisfied that they are all in the right places. Sometimes he finds a portion of his materials altogether unsuitable, in which case he takes it away to a distance from the intended nursery of his offspring, and, regardless of labour and fatigue, gets another lot of materials. He cements the walls as they arise, by rubbing against them, as he had done to the floor, and then sets about the roof, which he completes in a similar manner. His hardest work appears to be this cementing process; the vibrating of the body, by means of which he exudes the necessary mucus from the surface of the skin, seeming to exhaust him very much.

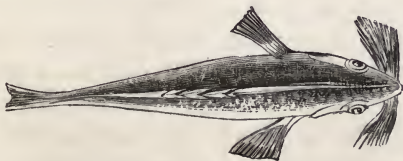
He makes two openings to his dwelling, a front and a back door as it were, which he retains in suitable form by passing continually through them in such a manner as to keep them neat and open. Some species build on the ground, others between small roots, near the bottom of the stream (see Plate V.); the species *Trachurus* and *Leiurus* preferring the ground, *Pungitius* the support of roots, etc.

When the nest is completed, combats often occur between males to keep or obtain possession; and then they have many polite ways of inviting a favourite female to come and take possession of the edifice they have constructed, always keeping guard during the time she is depositing her eggs (as shown in Plate V.), and wearing, in honour of the occasion, their gayest uniforms, frequently assuming bright scarlet and pure white on the joyful occasion. The male maintains his guard in full uniform until the spawn or eggs are all hatched, and the young fry begin to disperse in all directions. The nest is said to resemble that of the Long-tailed Titmouse, which, like it, has two entrances.

The assiduous duties of the male Stickleback appear to be reversed in the salt-water species, which, according to a communication from a lady at Aberdeen to Dr. Lankester, are, in the case of

that very distinct species, performed by the female. This assertion is founded on actual observation; a female of the species in question having formed her nest, deposited her spawn, and covering it carefully over, watched it assiduously, attacking any approaching enemy, just as is the habit of the males in the other species. The nest appears, however, to have been a far inferior structure to that of the male architects.

There are many other particulars relating to the nidification of these interesting little fishes; but space will not allow of further detail in this place. Enough has been said, however, to show how very interesting a colony of Sticklebacks might be made in an Aquarium, especially if all the species were collected, and their abode made sufficiently comfortable to induce them to feel quite at home and exhibit their curious nest-building instinct in full confidence and security.





CHAPTER VII.

GOLD FISH.

LONG before the Aquarium and its principles were understood, Gold and Silver Fish had become favourite pets, and were kept with more or less success in glass globes manufactured expressly. Their rich colouring and pleasing motions made them very ornamental, and many elaborate structures were invented for their display. The globes were placed on richly decorative stands, surrounded with moss and flowers, and in some cases an inner globe was contrived, open with wire-work at the bottom, into which Canary birds were introduced, to be seen perching on branches of coral as though actually disporting themselves in the water among the Gold and Silver Fish; white Mice or Guinea Pigs being sometimes substituted in the inner globe for the birds.

The effect produced was fantastic, and not unpleasing, and suited the imperfectly developed taste of the day; but in these times of international ex-

hibitions, and art treatises, and art novels, and even art sermons, the laws of taste—pure taste—can no longer be vitiated with impunity. Even the placing of *coral* branches or sea shells in fresh water would be sufficient to shock the very fastidiously accurate taste of our art critics, and the affected semblance of birds existing under water would be denounced in some cotemporary journal of “art, science, and literature,” in language of “crushing force and biting sarcasm.”

The bad taste, however, was not the only deficiency exhibited by a past generation of lovers of domestic pets. The principle by means of which fish could be kept in a healthy state in a confined space, when living plants are cultivated in the same water, was not then understood; and consequently, notwithstanding the greatest care and the changing of the water very frequently, the fish, in most cases, very soon perished, which was the main cause of their going “out of fashion.”

But now that we have mastered the necessary secret, and can keep aquatic animals in a glass vessel, arranged as a true miniature lake, we can resume our chamber intercourse with our old friends under more auspicious circumstances. We need no longer see them pursuing their interminable circuit

in the glaring light of their unsheltered globe, with the knowledge that, despite all our solicitude, the term of their existence will be very brief; for we shall take care that they have their little forests of *Algæ* and water-plants, and the broad leaves of Water Lilies, or the green veil of the *Lemna* tribe, not only to shelter them from too much light, which is injurious to them, but also to renew continually their supply of air as fast as they consume it. In addition to these advantages, we shall find their motions greatly varied and increased in interest and attractiveness by the plants, round and among which they will pursue their floating promenade with evident zest and enjoyment. (See Plate VI.)

With these newly discovered aids our old friends, the Gold Fish, may resume all their former interest, and a prettily planted Aquarium may be rendered beautiful and interesting without the introduction of any other creatures. When there is not an innate taste for the pursuits of natural history in general, I would almost recommend confining the attention to plants and Gold Fish, as the latter can be procured without any difficulty, and are more easily manageable than any other kind of fish.

The dealers should, however, be stimulated to vary their stock by the introduction of new kinds.

Amateurs should insist that the single old species, with its varieties and sub-varieties, no longer satisfies them (it being well known that the only kind yet introduced is esteemed by the Chinese the poorest of all), and that they now require some of the splendid species which are described as common enough in China, though never yet introduced into Europe.

The Gold Fish is a Carp (*Cyprinus aureus*, or Golden Carp), and is very closely allied to our less brilliantly coloured species. Its first introduction to Europe is variously dated as 1611, 1691, and 1728 ; the earliest seen in France were, however, those sent for Madame de Pompadour. Soon afterwards they became tolerably common, as it was found that they thrived well in the waters of Southern Europe, especially in Portugal, where, from a few small fish, said to have escaped accidentally from a vessel newly arrived from China, several of the streams in the neighbourhood of Lisbon soon absolutely swarmed with them, and it is from that source that our common supply is now generally obtained. At the Mauritius, where they also became very common, they are eaten as a delicacy.

Even in England they flourish greatly in water kept a little above the ordinary temperature. In some of the manufacturing districts, where water-

power is employed, the water becomes heated during some of the processes, and the mill-dams thus artificially warmed (sometimes to a very high temperature) have been found to be most favourable reservoirs for the breeding of Gold Fish. In such situations they have not only multiplied exceedingly, but have attained to a much greater size than in ordinary waters, however well sheltered. In some cases referred to, the heat of the water appeared too hot for anything living to exist in; but there are very extraordinary examples of the degree of heat in which fish will not only exist, but thrive.

Les Fontaines found a fish, the *Sparus* of Lacepede, flourishing in the hot springs of Barbary, in a temperature of 86° Fahrenheit, and other small fish, of the Mullet and Perch families, have been observed in these springs. De Saussure found Eels in the hot springs of Savoy, which raised the thermometer to 113° Fahrenheit; while Bruce, in the hot baths of Teriana, perceived small fish resembling Gudgeons, the water being so hot that he was astonished they were not boiled. Broussonet made several experiments to ascertain the extent of the endurance of fish with regard to heated water, and found that many species would live for several days in water in which he could not bear his hand; and Hum-

boldt and Bonpland perceived fishes thrown up alive and in apparent health from the bottom of a volcano, along with water heated to a degree that raised the thermometer to 210° !—being only 2° below boiling point. This proves, at all events, that water of a tepid heat would be highly favourable to Gold Fish, and perhaps to many other species; and if the breeding and rearing of fish for the table were more attended to, it might be found that all the fresh-water species could be made to multiply more abundantly, grow more rapidly, and attain a larger size, by the judicious introduction of warmth to parts of ponds or streams, which might be easily effected near to dwellings where forcing-houses are in operation, by means of an extended range of hot-water or steam pipes being made to pass through the ponds, or parts of the adjacent streams.*

Pennant tells us that in China every person of taste keeps Gold Fish, and that they make the crossing of the several distinct species quite a scientific business. They also succeed in taming them, so that they will come to the call of a whistle

* Fish also bear a great degree of cold, though it is not pretended that they flourish in it; it is said that Perch that have been frozen up in solid ice have recovered when thawed before the fire.

to receive their food. We are informed, by the same author, that the most beautiful kinds are taken in a lake in the province of Che-Kyang.

M. de Sauvigny, in his beautiful work entitled "*Les Dorades de la Chine*," describes several of the species and varieties to which I have alluded as desiderata, and from the carefully drawn and exquisitely coloured plates of his work, there appears sufficient ground for considering the species as distinct as many other kinds of Carp, which have also a strong family resemblance. The description of a few of the examples from the work quoted will be sufficient to show that if they are only varieties, they are very distinct ones, quite as distinct—to borrow an analogy from vegetable life—as the nectarine and the peach, or the lemon and the orange, though by botanists the lemon is only made a variety of the orange, as the nectarine is of the peach. The Chinese are, however, such accurate observers, that in all probability we may accept their views regarding distinct species, especially when we consider the minute attention that has been paid to fish in the Celestial Empire, not only as to the means of their capture, in which they excel all other nations, but also in their nomenclature and classification, the elaborate nature of which may be conceived when

we refer to the report recently forwarded by Sir John Bowring to the Registrar-General, from which we learn that the portion of the Chinese people who obtain a livelihood by pursuits connected with the fisheries is larger than the whole population of Great Britain and Ireland, namely, above forty millions, which Sir John estimates at about one-tenth of the present population of China. But whether the beautiful kinds of the Gold Carp about to be described be mere varieties or not, many of the fish are so remarkably distinct in form as well as colour as to be quite as desirable, in an ornamental point of view, as scientifically distinct species.

The original drawings were made by a native artist, under the superintendence of M. de Sauvigny, and most carefully engraved by M. F. N. Martinet, engineer and engraver of the *Cabinet du Roi*. According to this work, the Chinese reckon seven distinct species, each with its sub-varieties, of which M. de Sauvigny gives fifty-eight examples; from these I have selected the following:—

Of the Chinese species, *Kin-yu*, the variety called the “Mottled Beauty,” is very remarkable. Beneath, it is simply silver toned, but on the back and sides mottled with blue, yellow, black, and rose colour, the rose colour deepening to pure crimson at

the gills, and the black becoming deep and velvety along the ridge of the back, especially near the tail.

Another of the same species is the "Superb," which is nearly fifteen inches long. The under part of this magnificent fish is silver, but the back, which is remarkably broad, is splendidly varied with scarlet and black, the scales being delicately edged with metallic gold colour.

Another variety of this species is the "Small Blue." It is silver beneath, exquisitely flushed with pale rose colour, the whole of the sides and back being of a lovely metallic azure. Here is a prize for the Aquarium !

Again, a very distinct variety is the "Moor," or Darkling. It is a large fish, very nearly black on the back and sides, which becomes violet underneath, the whole of the scales being edged with a red-bronze tone.

Of the species *Ouen-yu* there is a beautiful variety, the ground colour of which is delicate flesh colour, upon which are large patches of full rich brown, like the markings of a piebald horse.

Of the *Long-tsing-yu*, or Dragon-eyed species, so named from the prominence of the eyes, which appear set in large semi-spherical tubercles, there are some remarkably beautiful varieties, among

which the "Telescope" holds a prominent place. He is a fine large fish, delicately marked with very light shades of scarlet, black, and grey.

Of the *Nin-eubk-yu*, or Nymphs, there are endless varieties, all beautiful. The one called the Amber Yellow is very distinct. His ground colour is silver, with fine large patches of delicate amber-yellow, not at all inclining to scarlet, like our common varieties—each patch deepening in the centre to a pure orange.

There is also the Ruby, a fish of exquisite beauty, being of delicate, semi-opaque violet-crimson, fading to a delicate rose colour underneath.

Of the *Ya-tan-yu* tribe or species, so named from the rotund, spherical, or egg-like shape of the fish, there are many very curious varieties: one, with a rich violet back, flushed with deep rust colour, whose native name M. de Sauvigny translates as the "ferruginous," is very singular; as is another with a drooping, fringe-like, scarlet tail, known as "Red Fringe."

The species *Kin-teon-yu* is very remarkable, and seems quite distinct. The tail and head are bent upwards, giving to the entire fish the form of a crescent; and they have the habit, it would seem, of throwing themselves over and over as they swim,

as tumbler pigeons do in their flight. The variety termed the "Blue Greening," a rich blue, flushed with orange, is very beautiful, as are several others.

In the *Kin-yu* division there is a species with rather large crimson spots bordered with blue, and another peculiar variety, entirely flesh colour, or "toute chair," as M. de Sauvigny translates the Chinese name.

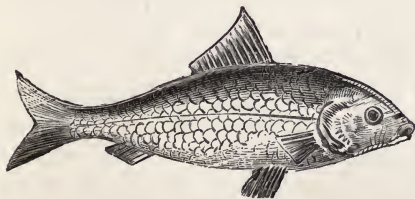
There is a sub-species of the Dragon-eyed division which have egg-shaped bodies, like the *Ya-tan-yu* family, one of which, whose entire colour is deep carmine, is very remarkable, and known by the characteristic name of the "Cherry."

The species *Ouen-yu*, or "lettered" kind, so named from their streaky markings, not altogether unlike Chinese characters, has some very pretty varieties, especially one called the "Elegant," a perfectly white fish—pure paper white—sparingly dashed with patches of pearly pink on the body, and having some exquisite letter-like markings about the head and tail. Another is rich scarlet, shading to black on the back, in the midst of which is a large cross of pure white, having *two* transverse bands, like the cross of Lorraine.

Among the *Nin-eubk-yu*, or Nymphs, I have omitted to name one peculiarly fine variety, called

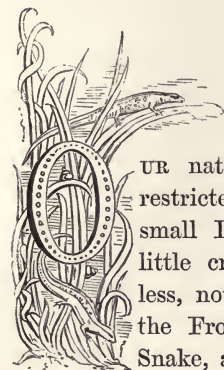
the “Pearly,” from the brilliantly changing nacreous hues with which his pure white is varied in different lights, and another called the “Red Fins,” a beautiful fish of delicate azurine tone, having the head, tail, and fins of intense scarlet.

Surely here is a list to tempt a speculator. Let a tolerably large tank be fitted up in some vessel trading with China, and well furnished with hardy water-plants before leaving the Celestial ports, and then there is every probability that a cargo of these magnificent fish would arrive safely in the port of London, and be the means of establishing most of the kinds in this country, where they might no doubt be easily acclimated. Such additions would impart quite a new zest to the pleasures of Gold Fish keeping, and make the Aquarium rich with colours that even the conservatory could scarcely match.



CHAPTER VIII.

REPTILES FOR THE AQUARIUM.



OUR native reptiles form but a very restricted family; a few species of small Lizards and Newts, all pretty little creatures, and perfectly harmless, notwithstanding their bad name, the Frog, the Toad, and the Hedge Snake, a beautifully marked, harmless creature, completing the list, with the exception of the Blind Worm, the bite of which in self-defence is perfectly free from venom; and, lastly, the only poisonous reptile of the native family, the Viper, or Adder, the virulence of whose bite has been much exaggerated. Bell, in his "History of British Reptiles," distinctly states that no well-authenticated case of death from the bite of a Viper is recorded, though inflammation of a serious character nearly always ensues.

One of the greatest advantages of all the countries of the temperate zones is their freedom, like England, from the presence of venomous and dan-

gerous reptiles, Ireland claiming to be, through the "interposition of St. Patrick," entirely free from reptiles of all kinds. The little Land Lizard (*Lacerta agilis*) is, however, common in that country; and Frogs were artificially introduced by an enthusiastic naturalist in the beginning of the last century. It is to a Dr. Gwythers that Ireland appears to be indebted for this addition to her natural productions. He first took over a large number of Frogs and placed them in the ditches of University Park, but all perished; and it was not till he bethought himself of obtaining some bottles of the spawn that he succeeded in establishing a breed of Frogs in Ireland. This happened in the time of Dean Swift, who, speaking of English abuses in general, says they multiply like a colony of Frogs, in allusion to the successful experiment of Dr. Gwythers. Every attempt to naturalize the Hedge Snake has, however, up to the present time, failed; all the attempts of a later naturalist to naturalize it in Ireland having hitherto proved abortive.

There are two kinds of Newts, or Water Lizards, suited to the Aquarium. The larger is *Triton cristatus*, the skin of which is tuberculated like that of the Toad, and may be said to form the Toad type of the Water Lizard tribe. This crea-

ture, though forming, as I have said, a kind of Toad division in his special family, is yet much handsomer than the Toad ; his long, slender form, and, in the early part of summer, the rich colouring of the under part of his body—orange, spotted with crimson—rendering him a very handsome creature : each tubercle, too, is ornamented with a bright speck of white, which produces a pretty sparkling effect. But I prefer the smooth, or Frog division, of the Newt family, all the individuals of which are exceedingly graceful creatures, and often very elegantly marked with rich colours, especially during the breeding season. •

There are two species of the smooth spotted Newt (*Lissotriton punctatus*). The lesser species is the handsomest of the two. The male (figured in Plate VII., No. 1) is of a full rich grey on the back, spotted with black ; and underneath, of a fine orange colour, enriched with large finely formed spots of crimson. The female (No. 2, in the same Plate) is less richly coloured. It is, however, only during the summer season that this great disparity of colour exists, at which time the male is also distinguished by a handsome fin-like crest, running the whole length of the back and tail.

A pair of the larger species (Nos. 3 and 4,

Plate VII.) exhibit similar peculiarities; they are more robustly formed than the species just described, but not quite so finely marked, the spots of the male, though more numerous, being not so large.

Towards autumn, about the middle of September, these elegant creatures generally leave the element of their nativity, and seek food among the damp grass of the meadows—returning to the pond or brook to hybernate. They will, however, live in water all the year round, though, after the gills of their tadpole state have disappeared, they are unable to remain entirely under water for many minutes together; and it is very interesting, in a tank, to watch them on a sunny morning maintaining their position, by “treading water,” as a swimmer would say, with their delicately formed little feet, occasionally rising to the surface for the necessary supply of air, and then sinking to the original situation, about half-way from the bottom—some favourite spot, favoured by a peculiar shade, or some other accidental attraction.

The addition of a little rocky island, on which the little creatures can bask occasionally, retreating to the water at will, is a great desideratum where Newts form part of the Aquarium colony.

The tadpole of the Newt, in its very early stages, is almost indistinguishable from that of the Toad or Frog. As it grows, however, the disparity becomes very evident, their elegantly spreading *branchiæ*, or external gills, assume a distinct form, and the tail continues to lengthen, while that of the Frog tadpole diminishes, till at last, even in their gilled or tadpole state, they become as distant as in their eventually complete form.

The Frog (*Rana viridis*), though a perfect aquatic in his tadpole state, is only amphibious when he attains his final development; and while his relative, the Newt, is able to remain in the water, as his element, after he has lost his gills, the Frog becomes more decidedly terrestrial, only seeking the water again in the breeding season. At other times, though he is an expert swimmer, and a most excellent diver, and able to remain long under water, he is, nevertheless, incapable of residing exclusively in that element, in which, in fact, he drowns. I have seen a full-grown Frog placed by dealers in an Aquarium, about which he swims till exhausted, and at last stretches out his limbs like any other drowning creature, resigning himself to his inevitable fate. In this last stage I have seen ignorant dealers stir him up with a little stick, calling

him a lazy fellow, and telling him to kick a little, and show the lady how healthy and robust he is.

It is impossible, from the causes just described, to keep full-grown Frogs in Aquaria; but it is well worth while to obtain some of the spawn in the proper season—April or May—and place a small quantity in the tank. The development of the tadpole from the egg state, till it is on the verge of becoming a perfect Frog, will afford a continuous succession of interesting phenomena for curious observation. Many interesting things might be told concerning Frogs, did space allow, but considering them as unfit inhabitants of the Aquarium, except in their tadpole state, this is not the place to dilate upon the history, the anecdotes, or associations connected with them.

The small Climbing Frog of continental Europe (*Rana arborea*) might, however, form a very pretty object for the island of the Aquarium, which, if only as a means of cultivating semi-aquatic plants, such as the Sundew and Forget-me-not, should always form part of the arrangement. If such a miniature island be made the abode of the Climbing Frog, a small branching twig, such as that represented in Plate VIII., on which the little creature is represented, should always be furnished. With such

means for displaying his gymnastic skill he will exhibit some very pretty antics ; sometimes suspending himself by one foot from a lateral branch, or holding on to four as distant twigs as possible by each of his globule-tipped feet. These little globules at the extremity of each toe are the additions to his structure which make him a climber, while his relative, the common Marsh Frog, unfurnished with these appendages, is compelled to remain a traveller on level ground ; his power of leaping, however, being, as is well known, very remarkable.

The colouring of the Climbing Frog is very pleasing. His full, soft green—not varnished, as in the common Frog, but only having what painters term an egg-shell gloss—is a very beautiful colour, something like that of the gem termed aquamarine, if it were but opaque, like the turquoise, instead of being semi-transparent. His sides are ornamented with a very delicate lateral streak of white, which seems like a line of demarcation between the upper and nether portions of the body ; and immediately under it is a narrow band of deep ruddy brown, which gives it a very bright effect ; the brown shading suddenly off to grey, which eventually fades into a porcelain white beneath. This elegant little creature has, in fact, more the ap-

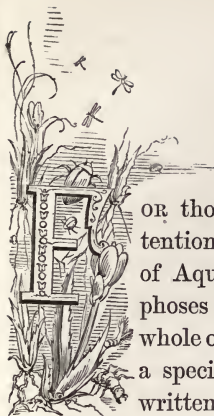
pearance of an ideal Frog beautifully wrought in Dresden china, than a real living and moving creature. Sometimes, indeed, he remains so long immoveable, in precisely the same position, as greatly to favour this notion; but he will suddenly catch a fly, or some other small insect, with such evident relish, as to remove at once all idea of his merely porcelain existence. In the neighbourhood of Weimar the Tree Frog is common, and the students nicknamed the military of Saxe-Weimar after these little creatures, in consequence of their green and yellow uniform.

That graceful and beautifully marked creature, the common Hedge Snake, might also be naturalized upon the island of an Aquarium, in which a little cave of retreat might be fashioned for him, lined with a few dead leaves. Into such a miniature cavern he would retire in chilly weather, and in winter wholly hybernate: while on sunny days, towards spring, he could come forth and bask on a convenient portion of the rockwork, or take an occasional bath, he being very fond of the water, in which his action in swimming is most graceful as well as singular. He should not, however, be placed on the same island as the little Frog, as, like some sections of the human race, he considers the Frog a

most nutritious and delicious esculent, and would be likely to act upon that conviction.

I do not dwell at greater length on the subject of Reptiles for the Aquarium, as I am aware that deeply rooted prejudices will cause many to exclude them altogether, restricting their selection of inmates for their tanks to plants and fishes only, to the exclusion even of aquatic insects, the interesting metamorphoses of which will form the subject of the next chapter.





CHAPTER IX.

AQUATIC INSECTS, ETC.

FOR those intending to devote their attention to the observation, by means of Aquaria, of the singular metamorphoses of those insects which pass the whole or part of their existence in water, a special and distinct work might be written, full of interesting and curious facts. In the present place, however, an allusion to a few of the most prominent must suffice, as in a general description of all kinds of animal life suited to an Aquarium, the more conspicuous classes necessarily occupy the greatest portion of our space, and are treated of in the greatest detail.

Among the larva stages of water-insects, those of the great Water Beetles are perhaps the most remarkable. That of the Margined Beetle, *Dyticus marginalis* (Plate III., No. 1), is a singular, scorpion-like creature, whose unprepossessing appearance has gained for him the unenviable appellation of the "water-devil." He scarcely belies his name—or that of the water-tiger, by which he is also known—as

his voracity makes him the terror of every other class of aquatic insect life. Woe to the Boat Beetle, or *Nepa*, coming within range of his dinner excursion—he is seized, and literally torn to pieces in an instant by this destructive creature. His change to the perfect, or beetle state, takes place in a structure which he forms at the necessary period, somewhat analogous to the chrysalis, or pupa case in which the caterpillar is gradually transformed into the butterfly.

This case contains the semi-torpid form, which developing itself into the perfect *Dyticus*, generally lies buried in the mud at the bottom of streams or ponds, or in the adjacent banks, in a secure spot selected by the larva, where he burrows to undergo his change in safety. From this receptacle the perfect *Dyticus* emerges in due time. He is a handsome swimming Beetle (Plate III., No. 2); but though improved in personal appearance, his habits have not amended—he is as voracious as in his larva stage. Small fish, even the Stickleback, in his plate armour, often become his victim, and the number of tadpoles he will consume at a long drawn-out meal, extending over great part of the fore and after-noon, is something extraordinary. A pair of these Beetles should not therefore be placed in an Aquarium, ex-

cept by themselves, or with such insects, etc., as are intentionally destined to be their food. They are, however, very handsome creatures, and so well worthy of observation is their structure and habits, that it might be worth while to fit up a small Aquarium as their especial habitation. Such an Aquarium should be covered over at night, as after dark these Water Beetles have the habit of quitting the water for a night flight in the air, to return to the water again at daybreak, a contrast in modes of existence thus enjoyed simultaneously, that no other class of either insects or animals are endowed with; for the aquatic fowl, which have the air also as their domain, do not in the water live beneath it, but only on its surface.

The larger kind of Water Beetle, the *Hydrophilus, piceus*, is much less voracious than the preceding species, so much so, indeed, that he may be placed in a tank with fish and other insects, without much risk of mischief, as he lives upon the smaller Crustacea and minute animalculæ. The larva, when about to change, comes out of the water, and burrowing in an adjacent bank, forms the pupa case for his change, similar to that of the preceding species.

The larvæ of our handsome Dragon Flies are

somewhat similar in form to those of the Water Beetle tribe, and, when about to change, it is very interesting to observe them leaving the water, and attaching themselves to the leaf of a reed or rush, just above the surface, where they become a kind of chrysalis, from the dull black husk of which the gaily coloured Dragon Fly eventually emerges.

A few of the larvæ of the Gnat should be placed in the Aquarium, if only to observe the interesting pupa or chrysalis state of this little creature. When the active little larva that we so often see frisking in sudden bounds in tanks of rain-water, is about to undergo his change from a water larva, or swimming maggot, to a graceful, aerial creature, his pupa form ascends to the surface of the water, where it floats in a singular, boat-like shape, till the creature within the tiny ark is fully developed ; at which period it is a most interesting sight to watch his efforts to escape from his floating prison, and see him at last take flight from its tiny prow to weave his mazes in the warm summer air.

But in hastening to speak of the more wonderful metamorphoses of the Gnat and Dragon Fly, I have omitted to mention some other species of Water Beetles which might form interesting subjects for observation in an Aquarium. Among these are the

Whirligigs (*Gyrinidæ*), so called from their whirling movements on the surface of the water, where their shining coats of bright bronze have a glittering appearance in the early days of spring. There are also the Water Boatmen (*Notonecta*) and the Water Scorpion (*Nepa*), well worthy of a place in the tank.

There are also the Caddis Worms of different kinds, which form interesting objects, clothed in their portable house of little sticks and stones (see Plate III.), which protects them from the attacks of fish or other insects. They are the larva stages of various species of *Phryganea*.

One of the most interesting creatures in a tank is the Diving Spider (*Argyroneta aquatica*), which, however, should not be placed with fish or voracious beetles, or he would soon disappear. The transparent membrane which surrounds the body of the Water Spider, and enables him to swim, gives him the appearance, when in motion, of a globule of quicksilver—an appearance which has rendered him a great favourite with keepers of Aquaria. There are other species of Water Spiders, but living upon the surface of the water, and not having the power of diving, they are not so attractive as the silvery, air-clad species. It constructs its nest in a singular

manner at the bottoms of brooks, and all its movements and habits, in pursuit of its prey, and otherwise, are curious and amusing.

From the Water Spider to the Crab, Shrimp, and other crustaceans, is but a step ; they are so similar in many points of their structure. The fresh-water Shrimp is worthy of a place in the Aquarium, on account of his peculiar method of swimming, but is so inconspicuous that few would take much interest in his proceedings on that account. Other small fresh-water Crustacea are curious as microscopic objects, but scarcely desirable for the Aquarium ; I therefore pass to the only conspicuous member of the family who has condescended to honour the fresh water with his presence. This is the Cray Fish of our brooks and trout-streams—the *Astacus fluviatilis*. He is somewhat difficult to manage, but many have failed, it would seem, in consequence of placing him in too deep a vessel, as Professor Bell, in his work on British Crustacea, describes one that was kept for a considerable time in a pan, only an inch and a half deep. A glass ledge might therefore be erected in the Aquarium, about that distance from the surface of the water, upon which a few pieces of rockwork might be formed into a retreat for the

Cray Fish, which, though tameable, is at first shy and shelter-loving. I have kept Cray Fish for a short time myself, and found great interest in watching them take their food—generally small pieces of raw liver—which I have let down to them at the end of a string. They have at first approached the proffered meat very cautiously; but gaining courage, have come boldly forward at last, and taking hold of the meat with a claw, as ready in its actions as a human hand, have carried it to their mouths, and devoured it with evident relish; occasionally using the other claw to tear off a tough piece, or otherwise assist in the operation.

One of these creatures is a very pretty miniature of a lobster (see Plate VIII.), and is a pleasing variety to the other forms of animal life in the Aquarium. It is a singular fact that, in the representation of this creature, in Roesel's beautiful work, he is represented in his living state as of a fine bright scarlet. This can scarcely have been the error of the naturalist, but rather that of the colourist in preparing copies for the bookseller which had not the advantage of the author's revision. The colourist, however, commits this special sin in good company; for I recollect a noble picture of the "miraculous draught of fishes," by no less

a hand than that of the great and accomplished Rubens, in which a lobster, scrambling from the heavily filled net as it is drawn up, is also painted a magnificent scarlet.

It will be seen, by the contents of the foregoing chapters, that the fresh-water Aquarium is able to afford as many attractive sources of interest as the marine, notwithstanding the Sea Anemones and richly coloured *Algæ*, which have made the salt-water tank so generally attractive. It is calculated at the same time to awaken an interest in natural history, in a province more generally accessible than the shores of the ocean ; for every brook, every pond, every ditch is filled with the curious and beautiful forms of animal and vegetable life respecting which the fresh-water Aquarium has awakened new or dormant interests ; interests which are all the more likely to meet with further extension, as the fields for additional investigation are open to all who have a pond in their garden, or even a small brook running through the neighbouring meadows.

THE END.

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